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ENGINEERING NEWS.

THE "WHITE STAR" STEAMSHIP *Majestic* has made the fastest maiden voyage from Queenstown, making the time 6 days, 14 hours and 45 minutes, thus taking the laurels from her twin-sister, the *Teutonic*. The entire run from Queenstown was 2,838 miles, an average of about 18⅛ miles per hour. The *Majestic* has twin propellers, with three blades instead of four, as in the *Teutonic*. The new steamship is 582 ft. long, 57 ft. 6 in. wide, and 39 ft. 4 in. deep. The gross tonnage is 10,000. The steamer can accommodate 300 first, 150 second and 750 steerage passengers. The promenade is 245 ft. long. The ship is finely fitted up and the appointments are luxurious. The floor is tiled with rubber, something that passengers who have weak "sea legs" will appreciate. The officers of the *Majestic* say that the machinery worked to perfection, and that the steamer was not pushed on the trip.

THE "*City of Paris*," says a Liverpool cablegram of April 14, is found to have broken one of her screw-shafts. The ship was docked on April 11, and on removing the casing covering the outboard screw-shaft the whole outer shafting is said to have fallen into the dock. Later inspection showed that the shaft in the stern-tube had broken clean off at the flange connection with the intermediate shaft. This discovery explains better than any previous theory the cause of the breakage of the starboard engine. The breaking of the shaft would produce racing in the engine, and when the high piston speed and the ponderous machinery are taken into account, the collapse of the engine is not remarkable.

THE TAMPICO JETTIES, says the *Times-Democrat*, of New Orleans, have been definitely located by Mr. E. L. CORTHELL, C. E., and work actively commenced on the construction of the six miles of railway between Tampico and the jetty-work. The Tampico division of the Mexican Central Railway has been completed, and on April 2, a through train passed from San Luis Potosi to Tampico.

THE ERIE & OHIO RIVER SHIP CANAL COMMISSION held a meeting recently at Pittsburg, Pa. EBEN BREWER, of Erie, J. M. GOODWIN, of Sharpsville, and Col. T. P. ROBERTS, of Pittsburg, were present. Mr. GOODWIN has spent some time among the engineers along the northern part of the route, and reported everything favorable. He stated that they had decided to cross the summit at a point near the Ohio line, to the west of where the old canal crossed. The new canal will be 70 ft. lower than the old one at the crossing. The survey will probably be completed by May 1, but specifications for the work will hardly be ready before the next meeting of legislature. The water supply for this new project is said to be entirely adequate to the demands, as the line runs through low lands and swamps for a long distance.

THE SECOND CAST-STEEL GUN TEST (of open hearth steel) has resulted unfavorably, like that of a year ago. In that test the gun withstood to ten service rounds, but showed signs of undue expansion and flaw, the significance of which was disputed. The second test duplicated the first both in number of rounds and the result. The expansion was doubled and three serious flaws developed. As the Bessemer steel gun went to pieces at the first round, cast-steel guns are for the present out of count. It does not follow, however, that further and continued experiment might not perfect them.

THE BROWN SEGMENTAL WIRE GUN has been very successfully tested on a small scale. The dimensions are: Calibre, 1 in.; length, 44 ins.; diameter at breech, 4 ins.; at muzzle, 3 ins.; weight, 70 lbs. It consists of 24 segments of steel wound with steel wire of $\frac{1}{2}$ in. in diameter, at a uniform tension of 100 lbs. At the breech are 22 layers and at the muzzle 9. There is no lining tube, the rifling—one turn in 25 calibres—being cut on the inner edges of the segments. The total pressure over the powder chamber is 7,000 lbs. per sq. in., and the pressure necessary to burst the gun would be about 150,000 lbs per sq. in. The success of this gun has satisfied the inventor's friends, and a 5-in. gun has been ordered and will be completed in July. The rapidity of construction possible in this design is one of the great advantages claimed for it, and if a 5-in. gun, built in three months without even a special plant to do the work, equals the penetration of similar guns now used in the navy, it is thought it may supplant the forged guns, which require about three times as long for completion. The 1-in. gun sent a steel projectile through three 1-in. plates, developing an initial velocity of 2,570 ft. per second, with a chamber pressure of 50,000 lbs. per sq. in.

The wire for winding this gun was made at the Carpenter Steel Works, Reading, Pa., from a special grade of crucible steel costing $1 per lb. It showed a tensile strength of 328,000 lbs. per sq. in., with 4 per cent. elongation, and 3.32 per cent. reduction of area. The elastic limit was 260,000 lbs. For combined strength and toughness, this record is a wonderful one.

GERMAN RAILWAY SUPPLIES, says Consul-General MASON, of Frankfort-on-the-Main, were quoted as follows at a letting of Dec. 6, 1889:

	Per ton of 2220 lbs.
37½ miles ingot steel rails, 5 ins. high.....	$37.50
18 " " 4½ ins. high.	38.08
8 " "	39.98
8,409 ingot iron ties, 9 ft. long	36.89
Ingot iron switch ties.....	37.60
27,610 wrought-iron cross-ties.....	34.98

The bids above quoted were the lowest in each class and came from leading manufacturers in western and southern Germany. The prices were all for delivery at the railway station nearest to the works.

THE GROSS EARNINGS OF 129 RAILWAYS FOR MARCH, according to statistics collected by *Bradstreet's*, aggregated $31,004,479, a gain over last year of 8.7 per cent. in earnings on a gain of 2.8 per cent. in mileage. This is the smallest per cent. of increase since July, 1889. The most noticeable point is the decrease in earnings of the Southern roads which heretofore have shown very favorable increases, and the large increase in the earning of the Southern lines, 16.3 per cent.

The earnings of 127 railways for the first three months of 1890, according the same authority, amount to $90,359,890, an increase over those of the same period of 1889 of 10.8 per cent. As in the March earnings, the Southwestern roads show the most favorable results; the gain being 17.5 per cent. The granger roads follow with a gain of 15.3 per cent., and the Southern and Central Western with gains of 11.8 per cent. and 11.1 per cent respectively.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision April 13 at Hamburg, Pa., on the Delaware extension of the Pennsylvania R. R. Two men were killed and two seriously injured. There has been no accident of special importance during the week, but about the usual number of minor accidents. A misplaced switch at Chicago turned an East Chicago dummy train on the Fort Wayne R. R., onto a side track, where it collided with a freight train. Three or four persons were injured. At Terre Haute, Ind., on April 13, an Evansville & Terre Haute switch engine hauling several freight cars on the Vandalia main track ran into an incoming Vandalia freight train. The Evansville & Terre Haute engine driver reversed his engine just before the collision. The concussion broke the connection between the Vandalia engine and the train, and both engines with the few cars attached to the switch-engine started to run through the city. They turned onto the "Y" leading to the Union Depot, and collided with a Terre Haute & Peoria passenger train ready to start west. One man was seriously injured.

THE FOLLOWING BRIDGE ACCIDENT is reported: The bridge over the canal about 2½ miles east of Clyde, N. Y., known as the Waldurf bridge, broke through, April 9, and let a team of horses and a man drop into the canal, about 18 ft. There was no serious damage. The horses were scratched a little, but the man got out all safe. A correspondent writes: "This bridge was a wooden, Whipple truss, 73 ft. clear span, and 16 ft. roadway, built by the canal authorities in 1879."

THE MISSOURI PACIFIC R. R. CAR SHOPS at St. Louis, Mo., were burned April 13. Seven passenger cars and a considerable quantity of fine lumber were destroyed. The bulk of the new work, however, has been done at the De Soto shops for some time.

AN EARTHQUAKE-PROOF CHURCH has been built at Manila, says U. S. Consul ALEXANDER R. WEBB. The church is 162 ft. long by 70 ft. wide and 52 ft. high and has a tower 32 ft. square and 114 ft. high. The entire framework is wrought iron; the walls are of double plate iron with a space of 30 ins. between the plates. The quite elaborate decorative work is made of cast iron. The total amount of iron used is 1,600 tons, and the cast iron cost $48.25 per ton; ornamental cast iron, $106.15, and wrought iron, including plating, $80.80 per ton, all f. o. b. at Antwerp. All the material was made and furnished by the Société Anonyme d'Enterprise des Travaux Public, of Brussels. The total cost of the ironwork was $280,000, and the masonry, flooring, painting, pulpit and interior decoration cost $50,000 more. Mr. WEBB thinks that as the fashion is now set, American ironmakers should look to it that they get their share of future work in these regions.

THE HUNGARIAN GOVERNMENT will contract for repairing the so-called "Eiserner Thor," and the cataracts on the lower Danube. The work will comprise the blowing up of rocks at rapids amounting in all to 212,000 cu. yds.; two breakwaters containing 800,000 cu. yds. of masonry, and 137,000 cu. yds. of paving; and a short ship canal. The third series will comprise the building of a ship canal at the Eiserner Thor. The works will be let separately, to be finished in 1895, and bids must be accompanied by a guarantee deposit. Further details, blank forms and drawings can be obtained of the Consul-General of Austria Hungary in this city.

THE FORESTS OF EUROPE, according to a late report of one of the State foresters of Prussia, cover the following areas: Germany, 34,596,600 acres; Russia, 494,228,600 acres; Austria-Hungary, 46,951,700 acres; Sweden, 42,000,000 acres; France, 22,240,000 acres; Spain, 19,769,000 acres; Italy, 9,884,570 acres; and England, 2,471,000 acres.

AN ELECTRIC RAILWAY IN SIAM has been incorporated and will be built at once from Bangkok to Paknam, a distance of 30 miles. This road is to cost $400,000, and Siamese capital will alone be used. An electric light company has also been organized and the plant ordered for Bangkok.

SHIPMENTS OF TRINIDAD ASPHALTUM, says Consul SAWYER, amounted to 32,400 tons from Jan. 1 to June 1, 1889. The greater part went to the United States, and the amount stated was "a prodigious increase" over any previous semi-annual shipment during the history of the colony.

THE SPRINGFIELD ARCH PARAPET has been put into the form of an object lesson by the Boston & Albany R. R. Co. A great white screen has been stretched across the street, in height and breadth equal to the proposed 12 ft. parapet. According to the Springfield *Republican*, the public is of the decided opinion that the proposed "improvement" would really be a great disfigurement to the whole city. As we have more than once remarked in connection with this 12 ft. parapet, the effect is one of over-powering heaviness, entirely destroying the grace of outline and proportion of parts which belong to properly designed arch construction. The present scheme makes it evident that a 5 ft. parapet would hide the moving cars from horses and hence practically effect all the good expected from the greater surface. We unite with the *Republican* in hoping that the change to the lower wall may be sanctioned even at the eleventh hour.

THE ROUGH 40-IN. OBJECT GLASS, for the observatory at the University of Southern California, was shipped to Clark Bros., Cambridge, Mass., on April 14. It was made by MANTOIS, of Paris, and is said to be the largest lens of the kind ever made. In its present state it is a superlatively pure circular piece of crown glass, 40 ins. in diameter and 2½ ins. thick. It will be reduced to about 2 ins. in greatest thickness and about two years will be required for this work. It is to be finally mounted in a tube 60 ft. long, thus exceeding the Lick telescope in length as this object glass exceeds it in diameter.

Ship-building on the Lakes.

Shipyards on the lakes are to turn out vessels of 124,750 tonnage in the aggregate for 1890. At Bay City, the yards of F. W. WHEELER employ 1,100 men, and there are now under construction fourteen vessels of an aggregate value of $1,720,000. Further up on the Saginaw river, JAMES DAVIDSON has 600 men at work on nine boats, two of which are 3,000-ton wooden steamers with a contract speed of 13 miles per hour. Mr. WHEELER is now building two steel steamships for the Atlantic; they will be 275 ft. long, 41 ft. beam and 28½ ft. molded depth; they will each carry 3,500 tons with 20 ft. draught, and cost $225,000 each.

As the Canadian canal locks are too small to take vessels of this size, they will be towed to Buffalo, there cut in two by removing the rivets at a point where a permanent bulkhead crosses the ship. A temporary bulkhead in the other half, put in at the yard, will provide two distinct boats for navigation through the Welland and St. Lawrence canals, the lake and river, to Montreal. At the latter place the two halves will be again joined on a dry-dock, the ship will then steam to Newport News to carry coal to New York or Boston.

At Detroit, the Detroit Dry Dock Co. is finishing the last of six steamers for the Vermont Central ine, between Chicago and Ogdensburg. The *Mary and*, now being built for the Inter-Ocean Transportation Co., will be the largest carrier on the lakes, having a capacity of 3,500 tons. She will be finished in June, and is to be used in carrying ore from Escanaba to the rolling mills of South Chicago. Detroit has also two smaller yards.

At Toledo, O., the Craig Shipbuilding Co. has just completed the erection of a plant, and will turn out its first steel ship in June, sold for $155,000. The yards in Cleveland, O., are busy, and five steamships for the Lehigh Valley R. R. are afloat. Three other steamers are being built for the Minnesota Steamship Co. for ore-carrying purposes. Mr. H. H. BROWN, of Cleveland, has just had built for him the *Castalia*, an ore-carrier and a yacht combined. The Cleveland Shipbuilding Co. is constructing two large steel steamers for the Lake Superior Iron Co.

The Union Dry Dock Co., of Buffalo, N. Y., is building a steel steamer for a Buffalo syndicate, and another for the Wabash R. R. Mr. ALEXANDER MCDOUGALL has 1,000 men at work constructing his peculiar whale-shaped freight boats, turning out one every 60 days. The Chicago Shipbuilding Co., at Chicago, Ill., is building two steel steamers for the Minnesota Iron Co. The first is to carry 3,200 tons, with 16 ft. draft of water. Besides the yards here noted there are others at Milwaukee, Sheboygan, Manitowoc, Grand Haven, etc., chiefly interested in wooden ship-building.

The Moldau Viaduct.

We are indebted to the *Centralblatt der Bauverwaltung* for the following notes and cuts of the Moldau Viaduct at Cervena, in Bohemia. This structure carries the line of the Tabor & Pisek Railway over the Moldau River.

There are three spans, each 279.6 ft. long, and two stone arches, one of 19.7 ft. span at the Tabor end and the other of 26.2 ft., at the Pisek end. The iron superstructure is on the cantilever system; the central opening contains the two 82-ft. cantilevers and the 110.8 ft. suspended truss. The trusses have parallel chords and are of uniform depth, viz., 31.17 ft. between centers. The Tabor pier is 190.3 ft high; the other is 208.4 ft., both measurements being from the top of the pier to the bottom of the masonry foundations. They are of coursed ashlar laid in Portland cement. The top course is 16.7 ft. by 25.9 ft; the first course above the foundations is 38.1 ft. by 47.6 ft. The total area of the two foundations is 4456.3 sq. ft.; they are built on solid granite beds and have a maximum load of 142.2 3 lbs. per sq. in. (10.3 tons per sq. ft.) The stone was quarried from the slopes of the hills near the place in which it was to be used and roughly dressed on the spot. The mortar was composed of one part of Perlmoser Portland cement and three parts sand.

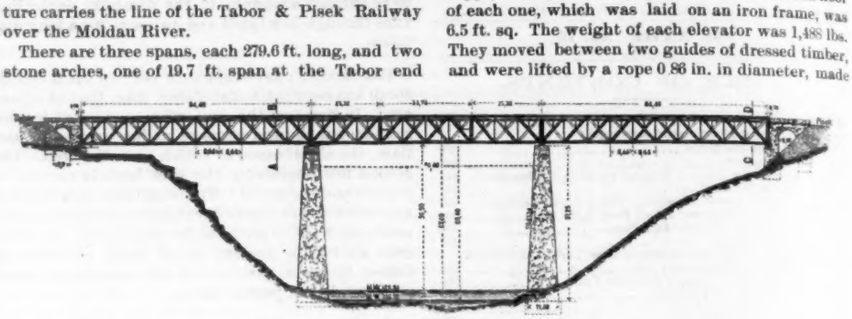


Fig. 1.—Moldau Viaduct at Cervena.

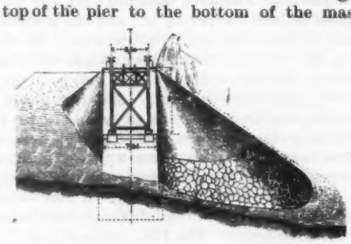


Fig. 2.—Section on C. D.

Fig. 3.—Pier and Section A. B.

The work of preparing the foundations was begun in December, 1886, under the direction of government engineers. By the middle of April, 1887, 1018 cu. yds. of masonry had been laid on the right bank of the river and 2011 cu. yds. on the other, and the top courses were level with the high water mark. After the lapse of a year, the work was resumed by Redlich Brothers & Berger, in May, 1888. The quarries were opened and the scaffolding at once prepared. By Aug. 10, 1888, the day when the elevators were first used, the piers were already 43 ft. above high water.

Figures 4-8 give a general view of the situation of the bridge and the scaffolding employed in the construction of the piers. The latter was built in stages, each 26 ft. high, as the needs of the masons demanded. These "stories" are divided into three parts by four rows of columns parallel to the axis of the bridge; the first part contains the masonry, the second the supply lifts, and the third the ladders leading from one stage to another.

The columns are strongly braced together, as shown in Figs. 5 and 6. Figs. 7 and 8 show the supply elevators on a larger scale. The wooden floor of each one, which was laid on an iron frame, was 6.5 ft. sq. The weight of each elevator was 1,488 lbs. They moved between two guides of dressed timber, and were lifted by a rope 0.86 in. in diameter, made of 84 strands No. 16 crucible steel wire (German gauge). The ropes pass up from the cages to a 6.5 ft. drum, and then down to the engine house, where they are attached to two cylinders of cast iron covered with wood. These cylinders are revolved in opposite directions, so that one cage ascends while the other descends. The motions of the cages are shown on an electrical indicator in the engine house. No safety brakes were provided.

The cars on the tracks along the banks of the river, passed to the cage over a turn-table, were raised by the lift, and then ran over tracks on the scaffolding to the place where the material was to be left. Sometimes it was necessary to lift the whole car from one place to another by means of the traveler shown in Figs. 9 and 10. The mortar was always prepared on the scaffolding near the place where it was to be used.

At each pier a 14 H. P. engine was employed to run the elevators. Besides this a small steam pump was used for pumping the necessary water for mortar to the different stages.

The works were lighted by five arc lamps, one at each pier, one in each quarry and one at the Pisek end of the bridge; many incandescent lamps were distributed about the scaffolding and engine houses.

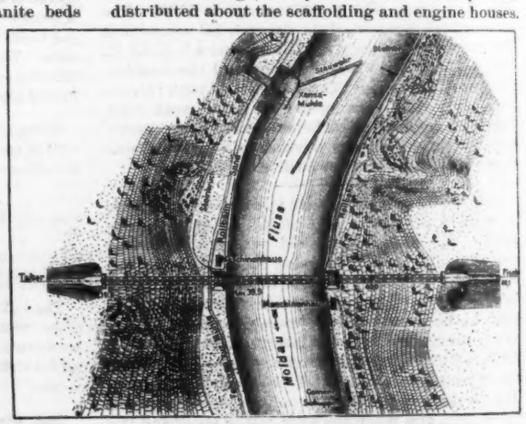


Fig. 4.—General Plan.

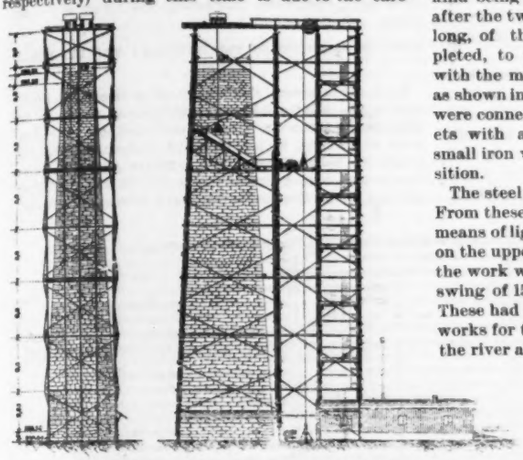
The electric current was produced by a Gramme dynamo driven by a 10 H. P. portable engine.

From Aug. 10, to Nov. 5, 1888, 5,805 ascents were made by the elevators on the Pisek pier; at the end of the time, the masonry was within 30 ft. of the final coping. On the Tabor pier, 6,003 trips were made in the same time, and the pier was within 48 ft. of the coping. Between these dates, 746 hours' work was done on the Pisek pier and 680 hours' work on the other. The amount of masonry laid was 5,423 and 5,265 cu. yds., respectively. It will be seen that the ascents of the lifts each working hour were 7.8 and 8.8, the cubic yards of material lifted each hour were 7.27 and 7.74 respectively. If a delay of 12 days, caused by unusual high water in September and October, is taken into account, we find that for each of the 61 days of active work, 82.4 cu. yds. of material were handled at each pier.

When work was stopped in November, 1888, the piers and houses were protected from high water by dams.

April 4, 1889, the masons again began work. On May 14 the Tabor pier, and on May 18 the other pier, were respectively completed. During this time 374 working hours had been spent on the first, and the elevators made 2,189 trips. These numbers became 271 hours and 1,378 trips at the second pier.

The smaller number of trips per hour (5.8 and 5.1 respectively) during this time is due to the care



Figs. 5 and 6.—Pier Scaffolding.

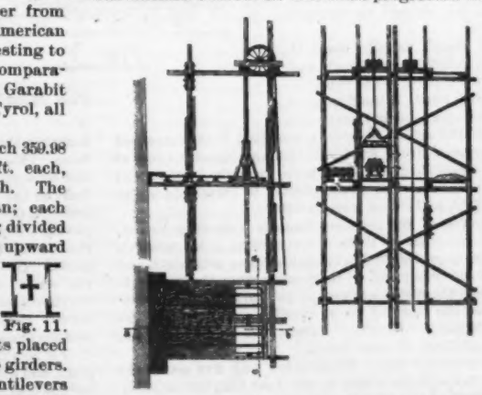
necessary in handling the coping stones, each containing about 4.6 cu. yds.

The following table shows the amount of masonry in the structures:

Place.	Masonry.					Scaffing.	
	Foundation.	Shaft.	Coping.	Arches.	Total.	Wood.	Screws.
	c. yd	c. yd	c. yd	c. yd	c. yd	c. yd	lbs.
Pisek pier.....	2,011	6,106	103		8,220	759	27,120
Tabor pier.....	1,019	6,102	103		7,224		
Both piers and end arches	17,382		256	138	17,778		

The character of the superstructure was determined by the nature of the site, the rocky cliffs and river beds rendering false-works impossible in the middle span. In the present case the engineers abandoned the usual method employed on the continent, viz., moving a continuous girder over from one abutment to the other, and adopted the American and English cantilever system. It is interesting to note that this method of construction is a comparative novelty in Europe; only the Duoro and Garabit viaducts and the Yoce Bridge in the Tyrol, all arches, having been so erected.

The bridge consists of two cantilevers, each 359.98 ft. long, the anchorage arms being 276.91 ft. each, and a connecting truss 110.76 ft. in length. The girders are on the double intersection plan; each panel is 27.691 ft. long, the upper chord being divided into half panels by vertical struts starting upward from the intersections of the diagonals. The distance between the centers of the trusses is 16.53 ft.; the track is 4.59 ft. below the top of the upper chord. The middle truss is carried by means of steel supports placed in the plane of the neutral axes of the two girders. For this purpose, the end posts of the cantilevers are made of a box section, and completely surround the end posts of the suspension link, which are star shaped (Fig. 11). The supports are placed half way up the posts as already mentioned, and are divided so that the end posts of the middle truss can pass between them. A lateral motion of the link is prevented by means of the guide blocks *a a*, Fig. 12, which are placed between the adjacent surfaces of the chords of the two trusses, the chords of the suspension truss naturally lying within those of the cantilever. The chords are either box or channel-shaped,



Figs. 7 and 8.—Hoisting Apparatus.

The bridge is of Martin steel throughout. The dimensions were calculated in accordance with the specifications of the Austrian government. The maximum stress in the cantilevers was fixed at 12,000 lbs. per sq. in. (844 kilos per sq. cm.); in the suspended truss it was 11,000 lbs. per sq. in. (768 kilos per sq. cm.)

The side spans were built by means of falseworks, but the middle opening was bridged without anything of this kind being used. It was necessary, after the two free arms, each 83.07 ft. long, of the cantilevers were completed, to connect them temporarily with the middle link. This was done as shown in Fig. 12. The upper chords were connected by a plate; two brackets with an adjusting screw and a small iron wedge *K* kept the bottom chords in position.

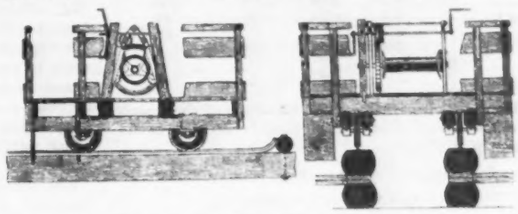
The steel was brought to the spot by supply trains. From these trains the separate pieces were taken by means of light cars running over a temporary track on the upper chords to the cranes at the place where the work was in progress. The crane had a free swing of 15.6 ft. and a lifting capacity of 6.6 tons These had done good service in erecting the false works for the side spans before being put in use on the river arms. A movable platform, 65.6 ft. long ran along the lower chords by means of ten wheels, and was pushed forward as the work progressed. Work was always begun on the lower chord of a bay first. The chord member was lifted by the crane, placed in position, and fastened by temporary bolts and pins to the end of the last member, this work being greatly facilitated by the diagonal tie *H*, Fig. 13. After both lower chords were in position, they were braced together, and the platform already mentioned run out. It was then easy to put the other members in place. Two or three days were necessary to complete a panel. The riveting in place was reduced to the lowest possible amount; of the 329,000 rivets which the bridge contains, only about 85,000 rivets were driven in the field, the others were driven by hydraulic riveting machines in the shops. During erection, all rivet holes were filled with bolts and pins, and the workmen who headed the rivets followed the others as rapidly as possible. A small movable platform ran along the upper chord for their use.

The work of erection began Aug. 1, 1889, on the Pisek bank and Sept. 2, 1889, on the other. The center of the middle span was reached by the men on the Pisek arm on October 6; the entire bridge was finished October 20. The work progressed without any accident to the end. There were about 90 men at work on each side of the river at a time.

The bridge contains 990.99 tons of Martin weld steel (flusseisen), 41.03 tons of Martin cast steel, 1.43 tons wrought steel, 6.16 tons lead and 13.2 tons galvanized corrugated plates for the floor. The dead weight per running foot was therefore about 1.2 tons.

The false works contained 262.76 M. ft. B. M. of wood and 16.5 tons of bolts; Redlich & Berger were paid $9,610 for building them. The work on the bridge proper was conducted by the Royal Bohemian-Moravian Machine Works, in conjunction with the Prag Machine Co., Ltd. The total cost of the steel superstructure and the false work used in its erection, together with the expense of laying the floor and track, was $160,000. The earthwork and masonry cost about $95,000.

The work was done under the direction of the



Figs. 9 and 10.—Traveller-Base.

Government engineers, Messrs. BISCHOFF and HUSS, and the engineer of the railway, Mr. KLEMENCIC. Mr. MELTZER was the resident engineer.

Experiments on the Effect of Rate of Speed in Testing Steel.

BY BERTRAM P. FLINT.

In the testing of iron and steel it has been noticed of course, that different rates of speed produce varying results. As regards the tensile strength all agree that, within certain limits, the faster the speed with which iron or steel is pulled apart the greater the maximum load. But just how the stretch and reduction of area are affected are points on which there is a diversity of opinion. The following experiments show conclusively how the ultimate strength and reduction of area at least are affected in the case of steel.

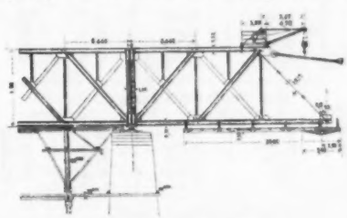


Fig. 13.—Erection Plan.

The material used was open hearth steel in the form of ¾ in. round rods, rolled from 4 in. square ingots. The rounds, it will be seen, have not had much work upon them and the results can not be expected to equal those obtained from a billet, hammered or rolled from a 10 in., or larger, ingot. Six bars in all were tested. Each was about 30 ft. long, and of a different melt. The test pieces were cut 18 ins. long, so that each bar furnished 20 specimens, or five for each of the four speeds used. Care was taken to equalize as much as possible any differences in the results, arising from the temperature of the bar varying throughout its length during rolling. So that, numbering the pieces cut from the bar from end to end, Nos. 1, 5, 9, 13, 17 were tested with speed No. 1; Nos. 2, 6, 10 14, 18, with speed No 2; Nos. 3, 7, 11, 15, 19, with speed No. 3; Nos, 4, 8, 12 16, 20, with speed No, 4,

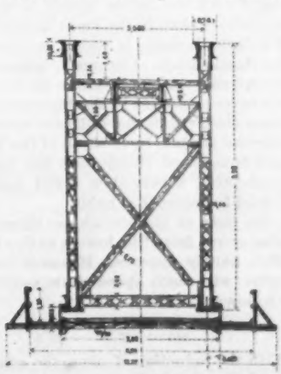


Fig. 14.—Cross-Section of Truss.

The following are the analyses of the several bars:

	Carbon. Per cent.	Silicon. Per cent.	Phosporus. Per cent.	Manganese Per cent.
Bar 1	0.15	0.065	0.078	0.41
Bar 2	0.15	0.045	0.088	0.38
Bar 3	0.19	0.058	0.078	0.60
Bar 4	0.25	0.039	0.095	1.14
Bar 5	0.30	0.070	0.072	0.96
Bar 6	0.41	0.054	0.083	1.02

				Ratio.
Speed	1	corresponds to	0.16 inches per minute	1
"	2	"	1.06 " " "	6
"	3	"	2.20 " " "	14
"	4	"	4.40 " " "	27½

The following table gives a summary of the means of all the tests; that is, each item in the table is the mean of five tests:

Effect of Speed on Tests of Steel.

BAR NO. 1; 0.15 CARBON.

Speed.	Ratio.	Elastic Limit.	Ultimate Strength.	Reduction of Area.	Elongation.
1	1	42,975	65,350	57.8	27.5
2	6	42,530	65,972	58.8	27.3
3	14	43,510	66,150	54.8	26.6
4	27	42,640	66,356	57.0	27.8

BAR NO. 2; 0.15 CARBON.

1	1	45,230	67,710	53.1	27.4
2	6	44,714	68,278	54.6	26.4
3	14	45,500	68,610	54.2	26.6
4	27	45,494	69,250	53.6	26.2

BAR NO. 3; 0.19 CARBON.

1	1	47,500	72,605	54.2	25.3
2	6	47,195	73,160	55.0	24.8
3	14	47,870	73,778	52.0	25.1
4	27	47,477	74,157	54.0	23.6

BAR NO. 4; 0.25 CARBON.

1	1	51,820	80,337	46.2	22.4
2	6	51,840	81,000	47.8	22.5
3	14	51,886	81,340	47.8	22.8
4	27	52,240	81,916	51.8	23.2

BAR NO. 5; 0.30 CARBON.

1	1	52,538	81,074	46.2	22.4
2	6	51,820	82,850	48.0	22.8
3	14	53,736	83,232	46.2	22.5
4	27	52,856	83,750	48.6	22.3

BAR NO. 6; 0.41 CARBON.

1	1	59,178	94,296	34.8	19.5
2	6	59,466	95,336	36.2	19.5
3	14	60,140	95,250	39.0	18.4
4	27	60,000	96,740	38.7	20.4

From an examination of the foregoing table it will be seen:

First.—That the altimate strength rises steadily with the increase of speed. The per cent. of gain of the highest over the lowest was in each case:

Bar	No. 1.	No. 2.	No 3.	No. 4.	No. 5.	No. 6.
Gain	1.5	2.2	2.1	1.9	2.6	2.5

The mean gain being 2.1 per cent.

There does not appear to be a noticeably greater gain in strength with the faster speeds in the case of the higher carbons than in the lower carbons.

Second.—No such increase is found or even expected for the elastic limit. Curiously, however, in every case except one, the employment of *the third* speed appears to be conducive to the highest elastic limit. This was observed in the ordinary way common to commercial testing, by the drop of the beam the same speed being used throughout the testing of one piece, excepting a very slow speed near the elastic limit, used to detect that point.

Third.—In the case of the stretch, we should expect a decrease, going from the lowest to the highest speed. This hardly appears. Means of the results of all tests with each speed show very little variation, as follows:

Speeds	No. 1.	No. 2.	No. 3.	No. 4.
Stretch	24%	23.8%	23.6%	23.8%

Fourth.—With the reduction of area, the effect of increasing speeds is plainly distinguishable. Computing means in the same way:

Speeds	No. 1.	No. 2.	No. 3.	No. 4.
Reduction of area	47.3	48.3	48.9	50.5

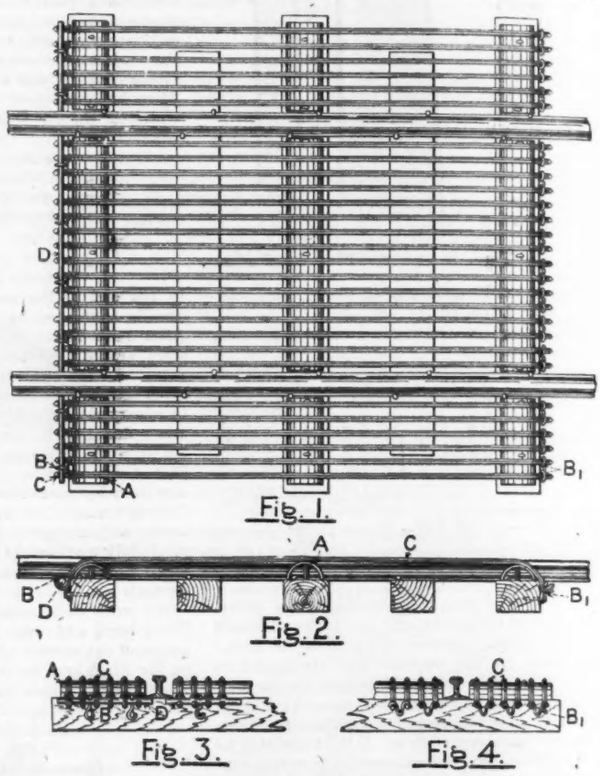
DOCTOR: (after the railroad accident)—"Are you much hurt?"

RAILROAD OFFICIAL: (faintly)—"I must positively decline to furnish any information."—*Judge.*

The Merrill Cattle Guard.

The drawing of the cattle guard which is illustrated herewith, has been sent us by a prominent engineer of maintenance of way, with the request that we publish it and obtain the views of the profession upon it, so far as opinion may be offered He expresses himself as very favorably impressed with it, and very justly adds that the pit cattle guard is for many reasons highly objectionable, making a rough riding track, greatly aggravating the danger of derailment, often ineffective from being partially filled, rotting quickly and heaving badly with frost.

The name of metallic cattle guards somewhat like this which have been put forward is legion. Some of them have had and still have warm friends; but we recall none closely resembling this one, the construction of which is so clearly shown by the drawings as to need little description. Figs. 3 and 4 show alternate modes of fastening the bars, which are ⅝ in. square, set cornerwise. Its great portability and lightness are points in its favor, but we leave its further consideration to our readers. The inventor is Mr. PARKER MERRILL, but beyond that we have no information.



The Merrill Cattle-Guard.

Protection of the Lower Mississippi Valley from Overflow.*

By Lower Mississippi Valley is here meant that portion of the valley below Cairo, lying between the bordering highlands and subject to overflow in time of high water. It is a region covering 7½ degrees of latitude (from 29½° to 37°), and has an area of some 20,000 square miles, being equal to the combined areas of Massachusetts, Connecticut, and New Jersey, or half as large as the State of Ohio. In other words, it is a fertile region of bottom land 500 miles long and 40 miles wide. A large portion of this region, perhaps half of it, would be unfit for agricultural purposes, even though it were protected from flood waters. But if this liberal deduction be made, there remains a strip of land 500 miles long and 20 miles wide, unexcelled in fertility, which might be cultivated with great profit if it were not subject to frequent overflow.

Great floods usually come at Cairo in February and March, and in the lower parts of the valley in March and April. If the flood gets off of bottom land in time to put in a crop, the cotton planter is benefited in the increased yield per acre. If the flood lasts through March he gets at best a small yield, and if it lasts through April he will plant none at all. The sugar-planter is greatly damaged by overflow, let it come when it will.

The source of the greatest floods is in the Ohio Valley, and the occasion of them is the melting of the winter's snow, accompanied by heavy spring rains, both north and south of the Ohio river. If these come when the ground is still frozen, the water is almost all poured into the streams. So far as the settling up of country contributes to the rapid discharge of surface waters, just so far does this cause contribute to great floods.

The Mississippi River Commission had five parties in the field through the whole of the year 1882, taking daily observations of the quantity of water discharged per second. From their reports we extract the following:

At Columbus, with 1,600,000 cu. ft., per second passing in the channel, we have 200,000 cu. ft. per second passing through the swamp.

At Memphis, with 1,150,000 cu. ft. per second passing in the channel, we have 650,000 passing in the swamp.

At Helena, with 1,540,000 cu. ft. per second passing in the channel, we have 360,000 passing in the swamp.

At Hays Landing, with 1,000,000 passing in the channel, there was another million passing in the swamp.

At Red River, with 1,600,000 passing in the channel, there was 600,000 passing outside, 300,000 of which passed down the Atchafalaya.

If all this flood water had been confined to the channel, there would have been added to the already overflowing river at the head of the St. Francis Basin 200,000, all along the central portions of this front some 600,000, and at the lower end 360,000 cu. ft. per second.

Along the central portions of the Yazoo front there would have been added some 800,000 to 1,000,000, and at the lower end, or at Vicksburg, some 400,000 cu. ft. per second.

At Red River there would have been added some 300,000, and at New Orleans about 1,000,000 cu. ft. per second to the maximum amounts ever carried by the channel in these parts, even when overflowing the levees along its banks.

POSSIBLE SOLUTIONS OF THE PROBLEM: THE LET-ALONE POLICY.

There are in general three methods of treatment open, each of which is feasible as an engineering problem. In addition to these we have nature's method, or rather want of method, in providing no artificial barriers to overflow. This latter demands no outlay, and allows the flood waters to find auxiliary passages to the Gulf, first through the St. Francis Swamp, then through the Yazoo, and then through Bayou Macon and the Atchafalaya bottoms. This policy has many advocates among river men, and some among planters themselves. Before levees were built on the Mississippi River, there were innumerable branches and bayous opening off from the main channel having a depth of many feet below the natural surface of the banks and discharging into the back swamp regions. These began to draw from the channel before the stage reached the top of the bank, and so overflows were less frequent and the maximum stages lower. These are now mostly closed, so that no water escapes from the channel except over the top of the bank. This it now freely does over the whole of the St. Francis front, and over the upper third of the Yazoo front, or as far down as Sunflower Landing, 120 miles by river below Memphis. From there to New Orleans the swamps are leveed out, except the Atchafalaya River itself, which opens out of the Mississippi at the mouth of the Red River. This is now really the continuation of Red River, so that at low stages there is no connection between the Red and Atchafalaya rivers and the Mississippi, the Red River discharging its water down the Atchafalaya to the Gulf. At higher stages the water flows from the Mississippi into the Atchafalaya, or vice versa, according to the relative stages of the two streams.

It is generally claimed, however, by planters in these bottoms that this policy of neglect would make agriculture so unprofitable that it would generally be abandoned, and that these regions would soon again become trackless forests, better fitted for habitations of bear, deer and alligator than for man. In fact, these bottoms

* Condensed from a paper read May 7, 1884, by Prof. J. B. JOHNSON, before the Engineers' Club of St. Louis.

are now cultivated only in proportion to the degree of protection obtained from flood waters.

ITS EFFECT ON NAVIGATION INTERESTS.

As to the effect of this treatment on the improvement of navigation, it would, I think, be beneficial, or at least not injurious. The argument is simply this: Since the bars are all formed at high stages, and the higher the stage the higher the bars are built, so any addition to the high stages by means of levees increases the bar-building influence. That is, in high stages the river always scours in deep places, and fills on the shoals, which is exactly what we wish to prevent. This results from the inordinate variations in the width of the river. To try to scour off the bars, therefore, by building levees on the banks, as they now are, is like trying to depress a ridge by piling earth on top of it. If no levees are built, the stage is kept several feet lower, and the bar-building process checked so much sooner, and prosecuted with so much less energy.

But here we are met by the counter statement that when the flood waters escape over the banks, the current in the channel is checked and the water drops a part of its sediment, and thus bars are formed. This is, in substance, the whole argument in favor of levees as a means of bar prevention. This is also the popular conception of the problem, and has nowhere been more strongly defended than before the Congressional committee. It is worth our while to examine this argument a little:

1. The river bed is a succession of narrow, deep and long pools, and short, wide shoals, the pools generally being in the bends, and the shoals on the crossings.

2. At low stages the slow current is in the pool, and the rapid current on the crossing. At higher stages the more rapid current is in the narrow pool, and the slower current on the wide crossing.

3. This variation in mean velocity from pool to shoal, and vice versa, is enormous, being as much as 250 per cent (4 ft. to 10 ft. per second) on the Plumb Point reach. (See Rep. Miss. Riv. Com., 1881, p. 120, pl. 7.)

Thus, with a six-mile current in the pool, and a three mile current on the crossing below, it is evident that sand will be washed out of the deep pool and deposited on the succeeding shoal. This occurs at high stages, and if the high stage continues long enough, this action will continue until the cross sections are so nearly equalized that a uniform velocity is attained. Again with a 2-mile current on the crossing, and a 1-mile current in the pool below, sand will be washed off the shoal crossing and deposited in the pool. This occurs at low stages, and if the low stage continues long enough, this action will go on until a uniform flow is reached.

4. Whatever checking of velocity there may be, due to flow over the bank (and there is no evidence that there is any such action on the Mississippi, below Cairo, due to overflow simply), it must be very slight, and if it should give rise to a deposit at all, it would be very small and would be made immediately below the point where the diminution occurred, whether shoal or pool, whereas the deposit of discontinuous suspended matter, above described, is all on the shoal places in high stages.

5. There are two ways in which velocity may be checked, which must be kept very distinct in our minds. We may have two different velocities in neighboring sections at the same time, or two different velocities at the same section at different times. Thus we may have a 5-mile current here in a pool, and a 3-mile current on the crossing a few miles below. This is of the first kind, is due to variable cross section, and causes sand bars. Or we may have a 5-mile current here to-day, and a few days hence but a 4¾-mile current at this same place. If this latter velocity were found at the same or higher stage than the former, and there was at the same time a general overflow, some would attribute the diminution to the fact of overflow. Suppose we grant this (which we do not), is there anything in this phenomenon tending to cause a deposit on the bars? This general diminution has occurred over long reaches of river, and is exactly analogous to a diminished velocity due to a falling stage. The average velocity over long reaches is not significant as affecting the sand-bars, but only the relative velocities at successive sections. If the general average velocity has been diminished simply, then the wide variations of velocity at neighboring sections are brought nearer together, and the bar-building energy is diminished exactly as is known to occur at lower stages. Any diminution of velocity, therefore, as indicated by a discharge curve, which simply shows the change of velocity at a given locality at different times, has no significance as affecting the height of sand-bars.

6. If there is a deposit of sediment in proportion to the checking of the velocity between two points, which is doubtless nearly true, then if the checking of velocity due to the variable cross section is 50 per cent., and the checking of velocity between these two points, due to overflow, is 5 per cent., the deposit causing sand bars, due to varying widths, is ten times as great as that due to overflow. If, however, this loss due to overflow has no necessary locality relation to the loss due to varying cross section, the two are as likely to be compensating as cumulative in their effects. If they are compensating, then the overflow is a positive benefit, for it then checks the velocity where it is inclined to be too rapid, and so tends to equalize the flow. It is highly probable that this is generally its effect. Most of the water that goes over the bank leaves the river in the bends, where the velocity at this stage is most rapid, and if this checks the velocity at all, it does it where it most needs checking.

7. This estimate of 5 per cent. loss in velocity due to overflow is more than is indicated by any of the discharge curves on the Mississippi below Cairo. In fact the Columbus and Red River curves do not indicate any actual diminution of velocity whatever due to overflow, and the observations at Helena are so discrepant that no certain conclusion can be drawn. The overflow was large in the vicinity of all these sections. But even if this diminution of velocity of 5 per cent. be allowed, for the sake of the argument, then by confining the water we increase the energy of a bar-building function which enters with a coefficient of ten, and diminish the energy of another function which is more likely to be with us than against us, but which only enters with a coefficient of one.

That is, we have a probable losing at the spigot, with a certain losing at the bung.

8. We may say, therefore, that troublesome sand bars are due to *local causes*, and these are mainly extraordinary variations in width in neighboring sections of the river. The remedy, evidently, is to narrow the channel over these wide reaches. This the Commission is doing, and is doing it probably as well as can be done. The Commission, however, favor levee building as an aid to bar removal, and in this we think they err.*

A COMPROMISE NECESSARY.

But the object of this paper is not to discuss the methods of improvement of low water navigation, but rather to study the subject of protection of the swamp region from overflow. The first method of protection, or rather the absence of method above described, though I believe conducive to the interests of navigation, would prove totally destructive to the agricultural interests of the valley. If the government will so regulate the width of the channel, however, that the building of levees will not prove any great injury, which will in time be done, then a compromise might be effected, and the inhabitants of the valley allowed to protect themselves by leveeing out the river from Cairo to the Gulf.

When this stage of advancement is reached, the following three methods of protection are open, all of which are feasible in an engineering sense:

First.—The system now in vogue, or levees confining ordinary floods but great floods always breaking through them.

Second.—The enormously expensive system of levees high enough to contain the highest floods.

Third.—A new system, lately adopted in France, of building levees to contain ordinary floods (such levees as are now built, for instance), with waste weirs, through which the surplus waters of great floods may escape without damaging the levees.

These three systems are all equally feasible as engineering projects. The questions of cost, benefit and injury remain to be discussed.

THE PRESENT LEVEE SYSTEM.

The first system, that now in vogue, is both expensive and unsatisfactory. It is a protection that costs millions of dollars, and yet does not protect. For three successive years these barriers have given way in scores of places, and a very large part of the country that contributes to their expense has been flooded out as thoroughly as though the levees had not been there. This system is therefore far from satisfactory to these people. It is also very expensive and troublesome.

In estimating the cost of this system we must include not only the cost of repairing the broken levees, but the damage done to private and corporation interests. These latter are practically incalculable. The repairing of the broken levees themselves would make this a very expensive system.

A POSSIBLE LEVEE SYSTEM.

The second expedient which we have mentioned is to build the levees high enough and strong enough to withstand the greatest flood that would likely come upon them. For this purpose the flood of 1882 might fairly be taken as a maximum flood, for it is doubtless the greatest on record. If we should allow a margin of two or three feet above the probable height the flood of 1882 would have reached if it had all been confined to the channel, we should probably have a levee that would hold any flood that would ever come. To examine the cost of this system we must decide what would be the probable heights to which such levees would have to be carried. On this subject we now have as accurate data on which to base our estimates as will ever be obtained until the levees are actually built and the resulting flood line observed. For the greatest flood on record (1882) the discharge was observed both in and out of the channel at Columbus, Helena, Hays Landing and Red River. The discharge tables, with their accompanying curves, are given in the current report of the commission. This report also contains computed discharges for every day in the year 1882 at three other points where elaborate discharge observations had been taken in previous years. These stations are Fulton, Tenn., Memphis and New Orleans. This gives us seven points on the river below Cairo at which the daily discharge is known throughout the flood period of 1882. If now we plot the discharges in cu. ft. per second, and the gauge heights, as the co-ordinates of a line, we will obtain a smooth curving line which we call a discharge curve. Since we have the actual observed values of both these co-ordinates up to a stage even with the tops of the levees, being many feet above the top of the bank; and since the regularity of the curve through a variation of stage of 40 or 50 ft. is so marked as to indicate a fixed law of dependence between discharge and stage, we evidently do no violence to the facts when we simply extend this curve a few feet further, say one-fifth of its present length, *and so predict what the stage would be for a given increase in the discharge.* This is the same kind of an argument that is used to determine the orbit of a heavenly body, only there the astronomer observes but a very small portion of the orbit, say 20 per cent., and predicts or computes the remaining 80 per cent., while here we have observed the 80 per cent. and only predict or compute the remaining 20 per cent. This is, therefore, the safest possible argument to use in determining what cannot be directly observed. The only assumption is, that as the river has done from a zero to a 40 or 50 ft. stage, so it will continue to do for a few feet further, if the conditions remain the same. And the conditions do remain the same if the levees are left in the same position and simply raised so high that no water will escape.

It has been thought necessary to enlarge on the nature of this argument, because the conclusions arrived at are so important, and to many they are so surprising as to seem incredible. This is the line of argument used by the President of the river commission in his exceptions to the report of 1883. I will give General COMSTOCK'S conclusions as to the increased height the river would have attained if all the water had been confined between levees in the flood of 1882. The estimates are but approximate, but I think err in being too small rather than too large. (See Rep. of Miss. Riv. Com., 1883, p. 25.)

At Columbus, Ky., there would have been added 200,000 cu. ft. per second to the channel discharge, giving an increased height of three feet.

At Fulton, Tenn., with 600,000 cu. ft. to be added, the increased stage would have been 10 ft.

At Helena, 300,000 cu. ft. would have been added, giving an increased stage of 4 ft.

At Hays Landing (or Lake Providence), the discharge of 1,000,000 cu. ft. would have been doubled, or made 2,000,000, with an increase of stage of 10 ft.

At Red River Landing, there was 1,600,000 cu. ft. passing in the main channel, 300,000 passing in the Atchafalaya, and 300,000 more passing overland. If this amount of overflow water were proportionately divided between the Mississippi and Atchafalaya, it would raise both streams by at least 3 ft.

At New Orleans, the computed maximum discharge for 1882 was 900,000 cu. ft. Since the maximum discharge in the channel at Red River was observed to be 1,600,000 cu. ft. per second, there must have escaped from the channel between these points as much as 700,000 cu. ft. per second at the top of the flood. If now 300,000 cu. ft. more had been added to the channel discharge at Red River, and all remained confined from there to the Gulf, it would have *doubled the discharge of the river at New Orleans.* As it was, the water overtopped the levees in many places, and many breaks were formed until sufficient relief was found to enable the levees to hold the remainder. In order to double the discharge at New Orleans, the increased stage would have been at least 10 ft. (General COMSTOCK does not estimate the increased stages at Red River and New Orleans, but the figures on which these estimates are based are all found in the report.)

The fact is, the mouth of Red River is properly the head of the delta, and has been for ages, so that the river at New Orleans never has had to carry more than 1,000,000 cu. ft., the balance having been always lost out over the banks and through natural outlets above. For us now to demand that this channel, which overflows with 1,000,000 cu. ft., shall suddenly be called upon to transport 2,000,000, is like passing a legal enactment that a quart measure shall hold two quarts of water.

There are some natural limitations to engineers' as well as legislators' demands. We now see how the concentration theory, carried out to this extent, means levees of ruinous cost, or else the utter destruction of agriculture on the upper and lower coast, and the actual submergence of New Orleans.

Since the increments of stage above predicted are all above the high-water marks of 1882, and since this high water generally overtopped all levees then built, it becomes a sufficiently alarming subject of inquiry. The practice of local and State authorities, wherever levees have been built on the Mississippi River, has been to build them about a foot above the highest known high-water marks, on the assumption that when the river was fully confined to the channel, the stage would be no higher than when allowed to spread over and discharge through

*It is worthy of note that Gen. C. B. COMSTOCK the President of the Mississippi River Commission, has always opposed the theory that levees aid in the improvement of low water navigation with the river in its present condition.

a swamp 50 miles wide. This method of reasoning was well enough when but small patches were to be leveed in here and there, but when the whole of any one of these great swamp basins is shut off, and the waters find no escape except down the channel itself, it should not be surprising that it should require a greater stage whereby to discharge the greater amount.

It is rather refreshing, therefore, to see that this very plain argument in favor of a higher flood stage for a confined channel nowhere receives so little credence as among these improvident sufferers, who, after 50 years of trial, have never yet built a levee high enough to keep a large flood out of any of their great swamp basins.

Taking the estimates for increased height due to confining all the flood waters by levees as above given, and allowing a foot or two for top of levee above high-water marks, we may say that such levees must average at least 8 ft. higher than those now built. In other words, all levees now built must be increased, on the average, to double their present height, and where there are now no levees they must be built to these enormous proportions.

The cost of a levee 16 ft. high, 8 ft. wide on top, and with slopes 3 and 4 to 1, as is recommended by the commission, allowing 25 cents per cubic yard, is about $50,000 per mile, which means a total additional expenditure of about *fifty million dollars* to confine such a flood as that of 1882 to the channel from Cairo to the Gulf, allowing also the Atchafalaya to discharge its full capacity.

The river commission have estimated eleven million dollars as sufficient for this purpose, basing this estimate on a height of levee 2 to 3 ft. above the flood of 1882 as being sufficient to prevent all overflow. This low estimate is the occasion of General COMSTOCK'S exceptions. In this estimate they agree, however, with the residents of these regions, whose continued faith in levees that have always failed them is something phenomenal. If eleven million dollars would really keep the river within bounds below Cairo, perhaps it would be wise for the States interested, simply as a profitable investment, to make the outlay. But if complete protection would cost fifty millions, it is very doubtful if it would pay a fair dividend. For the general government to build these levees, let the cost be what it may, would, in my judgment, be a great blunder. It would result in great injury, rather than benefit, to low-water navigation, and the benefits, such as they are, would accrue to the riparian owners, being private instead of public in their nature.

The incalculable damage, also, in destruction of life and property, in case a break should occur in one of these high levees, being in many places 25 ft. high, with a thickly-settled population behind it, should make one slow to put in jeopardy such great interests by making them depend on such frail and treacherous barriers.

The second method of treatment, therefore, is hardly feasible on account of its great cost, and because of its injurious effects upon low-water navigation.

THE PROPER SOLUTION OF THE PROBLEM.

We come now to the *third method*, which I shall offer as being more efficient and less expensive than the *first*, and as being less expensive, involving no risk, and less injurious to navigation than the *second method*.

The characteristic features of this system are:

1. Moderate-sized levees, or such as will keep out all moderate or ordinary floods, or such levees as are now found along the lower parts of the river.

2. Provision made for the discharge over these levees of the excess over the channel's capacity, in case of high floods, without injury to the levee.

3 Provision made for the conveyance of this flood overflow back from the river bank to the main drainage channels of the bottoms, with a minimum of injury from flooding the lands.

Whether levees be beneficial or injurious to low-water navigation, evidently their effect is less as their height is lower. The water is not usually over the top of the bank more than a month or two at a time, so the effect is correspondingly limited. Again, as the great variation in width becomes gradually reduced by means of the low-water works adopted by the commission, the injurious effects claimed for the levees, in the way of bar formation, will be diminished, and finally, for a regulated channel, their effect will become very small. In view of all these arguments, I think the opponents to levees would consent to a compromise, and be willing to allow a small injury to navigation in consideration of great benefits to be gained for the inhabitants of the bottoms.

Levees of this moderate size would keep out all ordinary floods that rise to a few feet over the banks, and so furnish complete protection against the regular annual freshets. They would probably be sufficient to confine the flood waters four years out of five. The floods of the last three years would all have gone over them. The trouble now comes with these exceptional floods. How shall we pass this excess of water from Cairo to the Gulf without its tearing to pieces these moderate-sized levees, which for four-fifths of the time are sufficient for complete protection? I answer that some artificial means must be provided to allow their excess to escape across the line of the levee without doing damage. This can only be done by arranging weirs for this escape, with revetted slopes, at such points on the line of the levee as will best relieve the river, and also where there are the best facilities for carrying off the flood water,

This is not an untried remedy. On the River Loire, in France, these weirs have been introduced to prevent the building of levees of extravagant height, and they have proved very efficient and satisfactory. On the Mississippi the great argument against them is that of cost, owing to the length to which they must be carried. Thus, for a depth of 2 ft. on the crest of one of these weirs, we would have a discharge of about 10 cu. ft. per second per lin. ft. of weir. To discharge 100,000 cu. ft. per second, therefore, would require 10,000 lin. ft. of weir. If a 3-ft. overflow be allowed, there would be needed only 5,800 lin. ft. of weir to discharge 100,000 cu. ft. per second, or to discharge 1,000,000 cu. ft. it would require 11 miles of weir with a 3-ft. depth on crest. In order to obtain this depth on the crest, the weir should be some four feet below the top of the levee, and so freely exposed to the channel that little slope is required to bring the water from the channel to the weir. These weirs must then be distributed in such a manner that the water, after passing them, may be most readily carried off to the distant low portions, where part of it remains impounded, as now, in every great flood, and the remainder escapes down the natural channels to the outlet of the basin. On all the great swamp fronts, there are many such favorable sites. As above noted, before levees were built, there were many natural outlets from the river to the swamps, and these could still be utilized and weirs placed so as to discharge into them.

The most favorable distribution of these weirs and the amounts to be discharged over each could only be determined after more elaborate surveys than have yet been made. The discharging capacity of these small watercourses is now very much lessened and in many cases almost entirely destroyed by "rack heaps," or "rafts" of stranded drift-wood, sometimes of miles in extent. If these were cleaned out and kept out, the stream would continue to increase its discharging capacity just as the Atchafalaya has done. There would be great trouble also in keeping the weirs free from drift. This possibly might be done by rows of piles in front of the weirs to intercept the drift, but these would have to be cleared frequently, or the accumulation would wholly cut off the weir from the channel. The arrangement of the details of this method could only be made after an elaborate study of the local conditions in each case, aided by extensive surveys of the region. My knowledge of the conditions found in these swamp basins as obtained in several years' engineering experience over a large portion of the distance from Cairo to Red River, especially my high-water observations in the flood of 1882, leads me to believe that the natural drainage of these basins could have been so improved as to have discharged all the overflow waters of that year with little damage from flooding cultivated lands, if the overflow could have been properly distributed as is here proposed by the weir system. These regions are cut up by innumerable bayous, running parallel to and away from the river, which could readily discharge the greatest overflow if they were properly cleared of all obstructions. As compared to these many cleared channels the discharging capacity of tangled forests and cane-brakes is almost zero, so that now, when there is a break in the levee, perhaps in the most unfavorable place for carrying off the waters, it overflows, in one common inland sea, forest cane-brake and plantation alike, and must slowly and laboriously find its way through these obstructions as best it may. The result is a stage of water behind the levees about equal to that in front of them. By the weir system, then, there would be much less water impounded in the swamps, and therefore the swamp discharges at Helena and Vicksburg would be much more prompt than now. But since other weirs are to be provided on the opposite side of the river, in each case, to take this surplus at once off into other channels, no great injury need be feared from this sudden return of the swamp overflow. This rapid discharge through the swamp is essential to a low stage of flood waters over these areas.

We can now revert to our original statement, that perhaps not more than one-half the area of these basins would probably ever come under cultivation, and we see what the other half is used for. The lower one-half is sacrificed that the upper or higher half may be utilized.

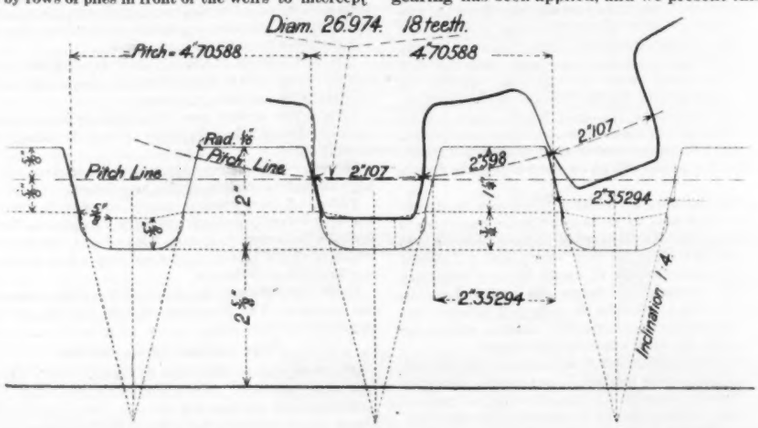
In comparing this system with the first, or that now in use, the cost of levee renewal, caused by breaks whenever the river overflows them, added to the damage done by the overflow, must be compared with the interest on the additional capital necessary to build the weirs and clean out these channels, to which must be added the cost of keeping the weirs in repair and the channels cleaned out.

If thought advisable, some provision might be made to keep the weirs closed, up to the tops of the levees, when there was reason to believe the flood would not reach so high a stage. The discharge over the weirs could then be under control, and as much water let out as desired.

In the method above outlined the course of the flood waters would be such as nature has provided, and such as every great flood has taken for thousands of years. It simply removes the obstacle to the rapid discharge of the overflow water and puts this overflow where the facilities of discharge are the greatest, and also allows to escape from the channel the minimum amount consistent with safety to the levees themselves. It seems to me to be worthy of a careful study, as furnishing to the swamp region a very fair degree of protection at a minimum expense, and at the same time being fairly free from the charge of injuring low-water navigation.

The Abt Rack-Rail System: Pike's Peak R. R.

In ENGINEERING NEWS, Dec. 7, 1889, we gave a description of the rack railway now under construction up Pike's Peak, in Colorado. It is the first railway in this country to which the Abt system of rack gearing has been applied, and we present this week



The Abt Rack-Rail System: Pike's Peak R. R. Elevation of Rack and Pinion.

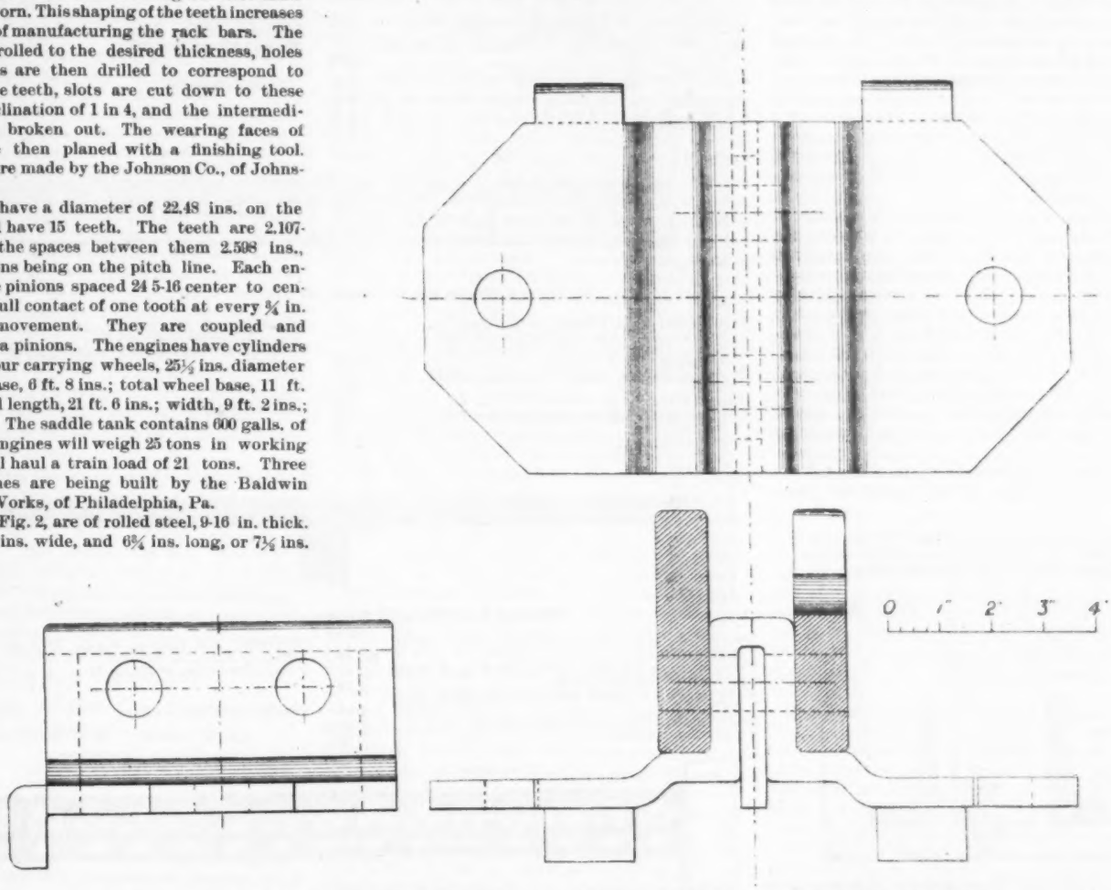
illustrations of the rack rail and the chairs in which it is carried. The rail is built up of two parallel lines of rack bars, so arranged that the teeth of one bar are opposite the open parts of the other bar. The engine pinions consist of two disks, similarly arranged as to their teeth, so that there are always two teeth in full gear, and others in contact with the rack. In this way a quiet, steady movement of the engine is insured, instead of the noisy and jerky motion of engines working on ladder-rack lines There is also much greater safety with the Abt system, as in the event of the breakage of one pinion or rack bar, the other is of sufficient strength to hold the train. With heavy traffic and on steep grades more than two bars may be used. The Pike's Peak R. R. will have the rack laid along its entire length, and the engine will be driven by the pinions only. In Germany some lines have the rack laid on certain sections having steep grades, and the engines work by combined adhesion and gearing; on ordinary parts of these lines the pinion is at rest. This system of working, as applied to the Harz Railway in Germany, has been described and illustrated in ENGINEERNG NEWS, May 22, 1886.

The rack bars of the Pike's Peak R. R. (Fig. 1) are in lengths of 80 ins. They vary in thickness from ⅜-in., weighing 73 lbs. each, on the easier grades, to 1¼ ins., weighing 104 lbs., on the steeper grades. The corners are rounded off with curves of ⅛-in. radius. The height is 4⅝ ins., the teeth being 2 ins. deep

The pitch is 4.70588 ins.; that is, the length of the teeth and spaces is 2.35294 ins. on the pitch line, which is ⅝-in. below the top of the bar. The sides of the teeth are inclined 1 in 4, and the lower part or root of each tooth, for ¾-in. from the bottom, is slightly undercut, to allow a clearance for the points of the pinion teeth when the wearing surfaces shall have become worn. This shaping of the teeth increases the difficulty of manufacturing the rack bars. The steel bars are rolled to the desired thickness, holes of ¾-in. radius are then drilled to correspond to the roots of the teeth, slots are cut down to these holes at an inclination of 1 in 4, and the intermediate piece then broken out. The wearing faces of the teeth are then planed with a finishing tool. These bars were made by the Johnson Co., of Johnstown, Pa.

The pinions have a diameter of 22.48 ins. on the pitch line, and have 15 teeth. The teeth are 2.107 ins. long, and the spaces between them 2.598 ins., both dimensions being on the pitch line. Each engine has three pinions spaced 24 5-16 center to center, giving a full contact of one tooth at every ¾ in. of forward movement. They are coupled and driven by extra pinions. The engines have cylinders 17 x 20 ins.; four carrying wheels, 25½ ins. diameter rigid wheel base, 6 ft. 8 ins.; total wheel base, 11 ft. 11½ ins.; total length, 21 ft. 6 ins.; width, 9 ft. 2 ins.; height, 12 ft. The saddle tank contains 600 galls. of water. The engines will weigh 25 tons in working order, and will haul a train load of 21 tons. Three of these engines are being built by the Baldwin Locomotive Works, of Philadelphia, Pa.

The chairs, Fig. 2, are of rolled steel, 9-16 in. thick. They are 12⅝ ins. wide, and 6¾ ins. long, or 7⅛ ins.



The Abt Rack-Rail System, Pike's Peak R. R. Plan and Elevations of Chair for Rack Bars.

long over the lugs. These lugs are on the up-grade side of the chair, and by bearing against the side of the tie, prevent the chair from slipping on the tie; they also relieve the strain on the fastenings. The chairs are spaced 40 ins., center to center, being placed on every other tie. In the vertical part are two bolt holes, 3¼ ins. center to center, for the attachment of the bars. A packing plate ⅛ in. thick, 3 ins. deep and 5½ ins. long, is placed inside the hollow part of the chair, and the bolts pass through this plate. The fastening bolts are ⅞ in. to 1 in. diameter, according to the grade of the road and the thickness of the bars. Spring washers are used as lock nuts. Each chair is fastened to the tie by two heavy lag screws, 1 in. diameter, 7¼ ins. long, with a head 1½ ins. square. The ties are 9 ft. long, 7 ins. thick, and 8 ins. wide. To prevent creeping of the rack rail, there will be about 200 rock or masonry anchorages, to which the chairs will be secured by eye-bars and pins.

The track will be laid under the supervision of Mr. W. HILDENBRAND, C. E., of No. 1 Broadway, New York, who represents Mr. ABT's interests in this country. The line will be opened this summer.

Cement Tubes for the Cuneo Aqueduct.

The old water supply of the City of Cuneo, Italy, was conveyed through an open channel, about 6 ft. high by 2 ft. 3½ ins. wide, in a tunnel. This tunnel channel was in part arched over, and the lower part is still used for conveying water for watering streets and other than potable purposes. On top of this arch the new drinking supply was brought in in tubes made of cement.

The fall in a total length of 5,919 ft. is 77.8 ft., or about one in 76, which represents the pressure on the new pipes. Mr. G. PONSO, who describes this work in *L'Ingegneria Civile*, 1889, p. 125, was the engineer of the work; and he at first calculated that a pipe of cement of an inside diameter of 9⅞ ins. would have to be 7⅛ ins. thick. But by a series of careful experiments he reduced this thickness to 3.15 ins. He used Casale cement, and the cost was 42 cts. per linear foot; or, including all contingent expenses, 56 cts. per foot.

The plan adopted is not very clearly described but a curved iron plate set on top of the arch was used as a centering until the cement set, while larch frames were used for the sides. The core was made of an expanding iron cylinder. In winter the cement set in 12 hours; which was reduced to 7 hours by blending two kinds of cement. A length of 6½ ft. was built up at one time.

A New Fire-Proof Floor.

Reference has often been made in the columns of this journal to the magnitude of the fire loss in this country, and the waste which is continually going on, and which can only be remedied by abandoning our present common methods of building and adopting in their place some of the many forms of fireproof construction. From time to time illustrations have been presented in these columns of different methods of fire-proof construction which are growing in favor, and there is abundant evidence that the next decade is to see well nigh universal use of fireproof construction in all large and permanent business structures.

The one great obstacle to the use of fire proof methods of construction in this country has been the expense. With capital worth from 10 to 15 per

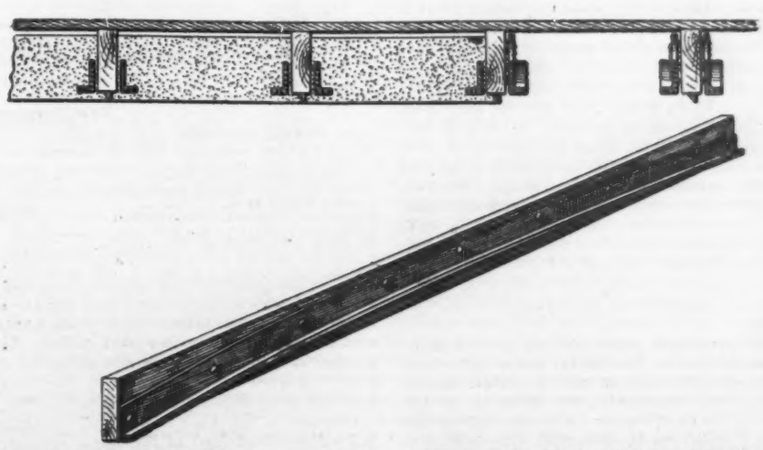


Fig. 1. A New Fireproof Floor. Cross-Section and Perspective View of Joist and Angle Iron.

cent., it has been cheaper to build wooden structures and take the risk of their burning. With the continual fall in rates of interest, however, this policy is fast becoming a penny-wise and pound-foolish one.

It is also true that fire-proof construction is much more expensive in this country than abroad. I beams, which form the girders in ordinary fireproof construction, cost here 3 to 3½ cents per lb., being quoted last week at 3.10 to 3.20 cents. In England they are now quoted at about $40 per ton of 2,240 lbs., or but little more than half their cost here.

The illustrations which we present herewith show a type of fire-proof floor which avoids the use of I beams, and which is claimed to be no more expensive than an ordinary wooden floor, a statement which any reader can verify for himself by reference to the accompanying tables.

The important feature in this floor is the use of good concrete, which, by the way, is a material too little used by American engineers. The details of the construction are clearly shown in the accompanying drawings. Fig. 1 shows a cross-section of the floor and a perspective view of one of the joists with the angle iron attached, and Fig. 2 is a cross-section of one of the joists on an enlarged scale, showing more clearly the details of construction. Of course the dimensions of the joists and angle irons and the thickness of the concrete are varied according to the load which the floor is intended to carry.

In a test floor which was carefully examined recently by a representative of this journal, the joists

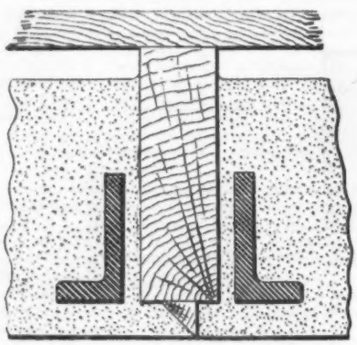


Fig. 2.—Enlarged Cross-Section of Joist.

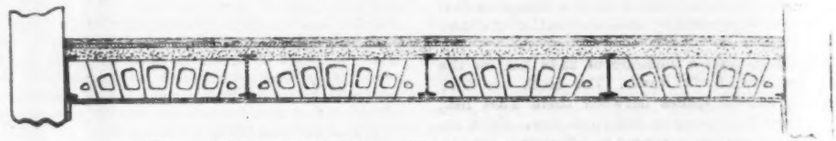
were 2 × 7 ins., spaced 2 ft. apart on centers. The floor was 6 ft. wide and had a clear span of 17 ft. It was erected merely for test purposes and was, of course, less strong than it would have been when placed in a building where the weight of the superincumbent walls would have given added strength, while the walls at the side would have prevented side swaying.

To each of the 2 × 7 in. joists was bolted two 2 × 3-in. angle irons weighing 12 lbs. per yd. The 3-in. leg of the angle was placed vertically, and they were given a camber of 2 ins. at the center. The bolts were ⅞ in. spaced 2 ft. apart, and a ⅜-in. washer was placed between the joist and the angle iron, giving the cement an opportunity to envelop both the wood and the iron. Upon the bottom of each joist is nailed a triangular strip made by halving diagonally an inch square wooden strip. The sharp edge is down, as shown in Fig. 2. Boards are nailed against these triangular strips, thus making a tight box into which the concrete is filled.

The concrete was composed of 1 part of Portland cement to 3 parts sharp bank sand, mixed with about an equal quantity of clean broken stone, sizes not above 1 in. diameter. The sand and cement were first thoroughly mixed and the broken stone was well wet down. The mortar and broken stone were then thrown together upon a mortar bed, and shovelled over. Much pains was taken to get the concrete at the right temper, not wet enough so that any water would rise to the surface when laid, or so dry that it could not be easily packed to fill solidly around the angle irons. The concrete was not rammed, but packed lightly with a rake as fast as placed. In filling it was the practice to begin at one end of a space and fill to the full height as fast as the concrete was brought, thus avoiding the formation of any horizontal layers in the mass.

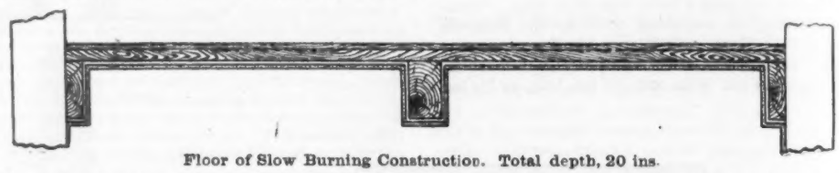
Floor of I Beams and Hard Brick Arches. Total depth, 14 ins.

Three 10-in., 90-lb. I beams, 16 ft. = 1,440 lbs.	
Two 10-in., 60-lb. channels, 16 ft. = 640 lbs.	
30-ft. ¾-in. ties, 2 lbs. per ft. = 60 lbs. = 2,140 lbs. @ 3½ cts per lb.	$74 90
Brick arch, grouting and centers, 225 sq. ft. @ 20 cts.	45 00
12 pcs. 3 x 4 in., 16 ft., 192 ft. B. M. @ $15 per M.	2 88
Flooring, 265 ft. @ $30 per M.	7 95
Labor, nails, etc.	8 40
Floor planing	3 00
Plastering, 25 yds. @ 30 cts.	7 50
Walls, 1,470 bricks @ $16.	23 52
	$173 15
Average framing	2 00
	$175 15



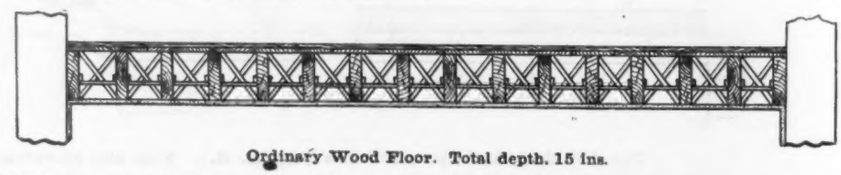
Floor of I Beams and Hollow Brick Arches. Total depth, 15 1-2 in.

Three 10-ins. 90-lb. I beams, 16 ft. = 1,440 lbs.	
Two 10-ins. 60-lb. channels, 16 ft. = 640 lbs.	
30 ft. ¾ in. ties, 2 lbs. per ft. = 60 = 2140 lbs. @ 3½ cts. per lb.	$74 90
Grouting, bedding sleepers 3 in. thick @ 40 cts. per sq. ft.	9 00
12 pcs. 3 x 4 in., 16 ft. = 192 ft. B. M. @ $15 per M.	2 88
Flooring 265 ft. yellow pine @ $ 30 per M.	7 95
Labor, nails, etc.	8 40
Floor planing	3 00
Plastering, 25 yds. @ 30 cts. per yd.	7 50
Walls, 1575 brick @ $16 per M.	25 20
Hollow brick arches, 10 in., 225 sq. ft. @ 30 cts. per ft.	67 50
	$206 33
Average Framing	2 00
	$208 33



Floor of Slow Burning Construction. Total depth, 20 ins.

Two pcs. 8 x 14 in., 16 ft. white pine, 298⅔ ft B M. @ $35 per M	$10 45
Plank flooring, 3 x 12 in. spruce, 675 ft. B. M. @ $25	16 87
Slip tongues, oak, 20 ft. @ $40	80
Flooring, 3 in., tongued and grooved, yellow pine, 265 ft. @ $30	7 95
Labor, nails, 3 days @ $2.75 ($8.25, $0.15)	8 40
Traversing, planing	3 00
Plastering and furring, 31 yds. @ 30 cts. ($9.30, $1)	10 30
Walls, 1,904 bricks @ $16 per M.	30 46
	$88 23
Average framing	20 00
	$108 23



Ordinary Wood Floor. Total depth, 15 ins.

Joisting, 16 pcs. 3x12 ins. x16 ft., 768 ft. B. M. @ $15.50 per M.	$11 52
Bridging, two rows, 40 ft. B. M. @ $15.00 per M.	60
Strips, 1x2 in. 80 ft. B. M. @ $15.50 per M.	1 20
Rough flooring, 6 in., tongues and grooved, hemlock, 265 ft. B. M. @ $20.00 per M.	5 30
Finish flooring, 3 in., t. and g., yellow pine, 265 ft. B. M. @ $30.00.	7 95
Traversing, planing	3 00
Time and labor, 3 days @ $2.75	8 25
Nails, 10 lbs. @ 3 cts.	30
Rough plastering, for deafening, 25 yds. @ 22 cts.	5 50
Paper	1 00
Walls, 1,580 brick @ $16.00 per M.	26 88
Finish plastering, 25 yds. @ 30 cts.	7 50
	$79 00
Average framing	9 75
	$88 75

New Fireproof Floor. Total Depth, 9 ins.

9 pcs., 2 x 7 ins., 16 ft., 168 ft. B. M. @ $15 per M.	$2 52
16 pcs., 2 x 3 ins., angle iron, 16 ft., 121 lbs. per yd. = 1,024 lbs. @ 2.4 cts. per lb.	24 57
72 bolts, ⅝ x 3 ins., 7 lbs. @ 5 cts.	35
Labor and time bolting angles, erecting centers, etc., 3 days @ $2 75	8 25
Concrete, 4 ins. thick, 25 yds. @ $1.	25 00
9 pcs., triangular, 1 x 1 in., 16 ft	50
Flooring, 265 ft. @ $30 per M.	7 95
Planing	3 00
Nails	30
Plastering, white coat, 25 yds. @ 8 cts.	2 00
Walls, 845 bricks @ $16 per M	15 12
	$89 56
Average framing	1 00
	$90 56

In the floor inspected the concrete layer was 5 ins. thick and filled solidly on the under side, so that a smooth surface was presented, on which a very thin coat of plaster finish made a good ceiling. The triangular strip also makes possible the entire enclosure of the wood by the concrete on the lower side, and thus gives additional protection from fire.

This floor at the time of the writer's examination had a distributed load of 102 bags of cement, each weighing 150 lbs., thus giving a load of 150 lbs. per sq. ft. With this load the deflection of the 17-ft. span was ¾ in. The only evidence of the strain upon the structure was a small crack on the under side of the floor near the middle, extending the width of the floor. The load has since been removed from this floor, and it has gone back to its original level.

Another test floor of 17 ft. span, with hemlock joists 1 × 7 ins., spaced 2 ft. 9 ins. apart, and angles 2 × 4½ ins., fastened by ¼ in. bolts, has been subject to a load of 70 lbs. per sq. ft., and shows a deflection at the center of 1½ ins.

No tests of the ultimate strength of either of these floors have yet been made; but, considering their small depth, and the small amount of strength in the wood and iron they contain, when tested under ordinary conditions, it is certainly surprising that they should sustain such heavy loads without permanent set.

In the new library building of the University of Pennsylvania at Philadelphia, now nearly completed, these floors have been used throughout. They seem to be very stiff as well as strong, which

might be expected, considering the manner in which the joists are bedded in the cement.

In the illustrations the joists are shown projecting above the cement, leaving an air space; but where it is desired to lay a tile floor, of course the cement can be carried to or above the top of the joists. There will be little question that the floor will stand fire, at least as well as the floor of iron beams and brick arches, since the wooden joists are only exposed at the top in any case. Among other claims made for this floor are the small amount of head room which it takes up, amounting to a considerable saving in the walls of any building in several stories, also the small expense for framing for flues, etc.

Probably much of the success of this floor is due to the excellent concrete used. It appears more like solid stone after setting than like ordinary concrete. Yet there is no especial mystery about its composition. Good cement, sharp sand, clear stone, thorough mixing and the right temper are all that is required.

Reference has been made to the relative cost of this and other common types of construction. The accompanying tables, for which we are indebted to Messrs. Furness, Evans & Co., Architects, of Philadelphia, show detailed estimates for a floor 15 ft. square built by each of five different systems. The prices are based on the usual rates of building contractors in Philadelphia.

Besides the new library building at the University of Pennsylvania, this floor has been adopted for the Bryn Mawr hotel, the Blair labratory, the new Williamson school and the house of G. D. COLEMAN at Lebanon, Pa. The inventor of this floor is Mr. FRANK FURNESS, of Furness, Evans & Co., of Philadelphia. The Fire Proof Floor Co., 220 South 3d St., Philadelphia, has been formed to take contracts for erecting this flooring or issue licenses for its use, and from them any further information can be obtained.

Side Dump Car, 80,000 Lbs. Capacity, New York, Lake Erie & Western R. R.

(WITH INSET.)

We present on our inset sheet this week the working drawings of an 80,000 lb. car built at the Susquehanna shops of the New York, Lake Erie & Western Railroad, which is not only of exceptionally great carrying capacity, but possesses several novel features in design.

The car is built to carry iron ore, taking it from vessels at Cleveland and delivering it at Ohio and Pennsylvania furnaces. It was originally designed to have only two four-wheeled trucks, but an emphatic protest was sent up from the engineering department against the proposal to carry 40,000 lbs. besides the dead weight of the car on a single four-wheeled truck, over the existing bridges and track, and the design was therefore changed, a third four-wheeled truck being placed under the center of the car.

To permit a side motion to the body of the car independent of the trucks in rounding curves, a roller bearing is used between the car body and the center truck. Four 7 in. rollers are used, each resting on a cast-iron bed on the truck bolster. The construction is such as to forbid any swivelling motion.

With this arrangement, the details of which are plainly shown on the drawings, there will probably be no trouble in rounding curves. There will be some side strain on the truck when the car passes on or off a curve, but it does not seem probable that it will approach in amount the side strains on the end trucks of an ordinary car.

As regards the distribution of the load to the three trucks, some interesting questions arise. It will be seen that the elasticity of the car sills and truss, and of the truck springs, are the only reliance for distributing the weight. The elasticity of a wooden car sill is a rather uncertain quantity. While the car is new it is probable that the center truck will not carry its share of the load. When the timbers from constant alternating strains become weak, it will be apt to take about the proportion of the load which it would have if the sills had a pin joint at the center, which is as nearly as may be one-third the load.

It is open to question whether it would not have been better to arrange the trussing for this distribution of the load from the first; and it will be evident from inspection that the trussing is not properly arranged to work well with a center support, even when running on straight and level track. When running over sags and humps, and when running on or off curves, the load of the center truck will be increased or diminished in an uncertain degree, dependent on the stiffness of the car sills, the height of the elevation or depression, the speed of running, etc.

It will be of much interest to note whether the transfer of a portion of the weight to the center truck has any tendency to cause derailment of the end trucks, especially when running slowly around sharp curves. It will be seen on examination that the front outer wheel of the leading truck, not only has to keep its own truck moving in a curve, in the usual way, but also has to cause the center truck to move in a curve, by reaction against the car body. In other words, the car body of this car resists motion on a curve by the amount of the resistance to such motion of the center truck, instead of it being a mere passive load, as in a two-truck car, so that the front outer flange has a much larger outward thrust against the outer rail in proportion to the load carried by it. This will certainly increase somewhat the tendency to derailment on curves, but this tendency is not so great that we should anticipate any great difficulty from this cause.

The dead weight of the car is given as 30,000 lbs. As the three trucks alone must approximate 25,000 lbs. in weight, this seems a very low figure, considering the heavy and substantial work on the ore pockets in the upper part of the car. However, as there is not a great amount of iron work about the car body, the weight stated may be nearly correct.

We do not now recall any other car ever built having three trucks and the weight distributed merely by elasticity. The Cleminson running gear, which has been and is used to some extent in England, is a 3-axled car, without equalizing beams, but it has complications necessary when a single axle is used which cause it to differ widely in its mechanical effect from the type now illustrated. The Cleminson running gear practically insures radial axles. Cars of 80,000 to 100,000 lbs. capacity seem to be growing in favor for special uses. The Pennsylvania is just building some of both these sizes for John A. Roebling's Sons, for carrying long wire cables; but these have four 4-wheel trucks, and the load is distributed in effect as if two ordinary 8-wheel cars were connected by a center-plate on each, with a superimposed car-body.

It seems pretty certain that 60,000 lbs. live load is as much as it will be wise to carry on two 4-wheel trucks. For cars of between 70,000 and 90,000 lbs. capacity three 4-wheel trucks are ample if the load can be equally distributed. It is quite possible that the plan illustrated in our drawings may answer very well, and give good satisfaction in service. It certainly is much cheaper than the use of 6 wheel trucks, which is a possible alternative. At any rate its performance will be watched with much interest, for whether it proves the best solution of the problem or not, it is certainly the simplest, and therefore deserves a fair trial.

The Amsterdam Water Supply from the Vecht.

The following details we abstract from the *Zeitschrift des Vereines Deutscher Ingenieurs*. The plan of supplying Amsterdam with water from the Vecht is not new. In the sixteenth century, when the water from the city canals had become unfit for use, water was brought from the Vecht in boats, and in the seventeenth century plans were brought forward for bringing water from the Vecht to Amsterdam by means of artificial conduits.

At the beginning of the present century NAPOLEON I. took this matter in hand and by a decree dated Oct. 21, 1810, commanded that water-works be built which should take their supply from the Vecht. No further plans were advanced until 1840, and in the meantime various efforts were made to obtain drinking water from wells. Between 1840 and 1845 various plans were canvassed for the establishment of a water supply for Amsterdam from the Vecht and even from the Leck. These all came to nothing, however, being supplanted by the plan for obtaining the supply of drinking water from the Dune. The Dune Water Co. was formed for this purpose, and first delivered water at Amsterdam in 1845.

For a while after the construction of the Dune water system the consumption was very small. Most of the inhabitants appeared to give the preference to the water brought in boats from the Vecht. Little by little, however, the consumption became greater. The city grew rapidly, and, as often happens in cities with a high-pressure system, the consumption per capita increased in even greater proportion. The Dune Water Co., therefore, was forced to extend its pipe system and to enlarge its pumping apparatus.

Notwithstanding this, the increase in the demand for water seemed greater than the increase in supply, so that means were considered for obtaining a still greater water supply. Attention was again directed towards the Vecht, and in the years 1880–81 the municipal authorities themselves took the matter in hand. After lengthy negotiations the above-named company undertook the construction of a water system from the Vecht in connection with its Dune system, which, however, was to furnish water for sewer flushing, street washing, and industrial purposes only, and not for domestic use. The terms of the concession fixed the capacity of the works at about 10,500,000 galls. per day.

The inlet sluice and the pumping station are about 2½ miles apart, since the latter had to lie within the fortification line, while the water is taken from the Vecht in the immediate neighborhood of Nigtevecht. The construction of the inlet gate chamber is very simple. It consists of two divisions. The wall on the river side has three openings about 60 ins. wide, each provided with an iron grating for preventing the entrance of coarse dirt. Grooves are provided behind the gratings for the reception of gates in case of repairs being necessary. The rear wall also contains three openings which can be closed with iron gates. This chamber is divided longitudinally by walls into three parts, so that the three inlet openings with their gates are entirely separated one from another.

The chamber on the land side is divided by an iron framework, the latter being provided with grooves for the reception of two series of perforated iron plates, into two parts. The openings in the plates are very small, and thereby the finer matters are held back. A traveling crane on the gate chamber serves for lifting out the plates for cleaning them.

The gate chamber is founded on piles, with a row of sheet piling on each side, and between the piling and the masonry is a puddle wall. The connection between the inlet gates and the pumping station is by a cast iron conduit.

The pumping station includes two settling basins, four filter beds, a clear-water basin, engine and boiler houses, workshops and storehouse, stand pipe, etc.

The supply pipe leads to two suction chambers in the engine house. From these chambers the water is pumped up into settling basins through two 30-in. mains. Each of these has two branches, one of which runs to the center of the basin and ends in a pipe projecting above the water level, so that the water flows over and falls back into the basin, thus aerating the water to a certain degree. To provide for difficulties which might occur during heavy frosts, a second branch has its opening near the bottom of the reservoir. The basins are provided with an overflow pipe opening into the supply main. The pumping engines can be connected singly or together with either or both of the settling basins by means of suitable valves.

After the water has cleared it flows through a 30-in. conduit, which runs along the filters and is provided with branches and stop-valves so that any particular filter may be used when desired.

On the other side of the filters is a 28-in. conduit with branches and stop-valves to the filters. This carries the water to the clear-water basin; from the latter a pipe 48 ins. in diameter carries the water to the suction chamber of the high-pressure pump under the pump house.

From the pump the water flows through two mains, which may be connected together by suitable branches and valves to the stand pipe. An arrangement is provided whereby the water can be pumped directly into the distributing system in case of injury to the stand pipe.

The settling basins are built upon raised ground. On account of the clayey nature of the subsoil the construction presented many difficulties. Each basin is about 350 ft. square and has a capacity of

10,500,000 galls. They are built with a layer of clay 12 ins. thick, and over this a layer of béton 8 ins. thick on the bottom and 12 ins. on the slopes, which are paved with Flemish brick.

Each of the four filters has a sand surface of about 53,000 sq. ft., and is similar to the settling basins in construction, and has a slight inclination toward the engine house. The bottom is not level, but presents a series of elevations and depressions. In the depressions, about 8 ft. apart, are perforated clay tiles, 4 ins. wide on top and 8 ins. on the bottom; these open on each side into masonry conduits provided with ventilating pipes. On the perforated pipes lies first a layer of coarse gravel 3 ins. deep; on this a layer of fine gravel 2 ins. thick; on this a layer of coarse sand 4 ins. thick, and finally upon this a layer of filtering sand 3 ft. thick. The water level is about 3 ft. above this sand.

The clear water basin consists of two divisions separated by a wall, each division being about 100 ft. long and 75 ft. broad, with a depth of water of about 11 ft. The capacity is somewhat reduced, however, by a number of cross walls, built for greater strength. Each part has a capacity for about 400,000 galls., and they can be connected together by means of conduit and stop valve. The excavation was carried down to sand, and the basins founded as a layer of béton. On account of the considerable earth pressure the side walls are arched, and outside of them is a béton and puddle wall to guard against any possible infiltration of ground water.

In the boiler house are 10 steel boilers in two groups, each boiler about 28 ft. long and 7 ft. in diameter. There are two duplex feed pumps, and the boilers can also be fed from the high-pressure pump.

In the engine house are four compound beam pumping engines, coupled two and two. At one end of the beam are the high and low pressure cylinders; at the other end is the low-pressure pump, *i. e.* the one for pumping the water to the settling basins. The high-pressure pumps stand under the high pressure steam cylinder, and are connected with the piston rod of the latter. The high-pressure cylinders have a diameter of 30 ins. and a stroke of 4 ft. 11 ins.; the low-pressure cylinders a diameter of 46 ins. and a stroke of 9 ft. The pumps are double-acting force-pumps and of the following dimensions:

Low-pressure pumps: diameter of bucket and plunger, respectively, 29 ins. and 20 ins.; stroke, 7½ ft. High-pressure pumps: diameter of bucket and plunger, respectively, 34 ins. and 23 ins.; stroke 4 ft. 9 ins. Valves of low-pressure pumps are of rubber, and of high-pressure pumps are entirely of metal. The capacity of the low-pressure pumps is about 220,000 galls. per hour raised 20⅛ ft.; that of the high-pressure pumps is about 192,000 galls. per hour, pumped to a height of 220⅛ ft. In the engine house is also a 12-ton crane and an air pump for pumping air into the air chamber of the pumps.

The stand-pipe consists of two cast-iron vertical pipes connected at a height of 180 ft. above the Amsterdam water mark, with two descending pipes, above the bend a single pipe rises to the before-mentioned height (220⅛ ft.) The whole is contained in a massive tower in the form of two squares, one within the other, the space between them being utilized for the stairs leading to the top.

The two mains leading from the pumping station to the city are 24 ins. and 27 ins. in diameter. They connect with the distributing system, which at present has a length of about 10¼ miles, at the Minder gate. The largest basins in the distributing system have a diameter of 30 ins. The execution of the work had to be carried out in the face of many difficulties. The bad character of the subsoil greatly increased the cost. Administrative difficulties in consequence of the protestations raised by various water companies and private individuals against the laying of the pipes had also to be met.

The total cost of the system amounted, therefore, to about $3,000,000. These difficulties likewise delayed the opening until April 1, 1888, instead of November, 1887, as was stipulated. The results thus far have been much below the anticipations. The hopes that the consumption of the Vecht water would extend have not been realized. In spite of the utmost efforts, the contracts closed by the company for Vecht water up to October, 1888, were only about 200 in number. The volume of water pumped weekly amounts to not more than 16,000,000 to 18,000,000 galls., *i. e.*, not one-fourth of the capacity of the system as designed, and of this the greatest part is used for street washing.

On this account, so far, little can be said of the more or less economical working of the pumps, since the latter are working under abnormal conditions. The consumption of coal varies from about 2,500 to 3,800 lbs. per 1,000,000 galls. pumped.

The Resistance of Steam Rollers.

A recent number of the *Centralblatt der Bauverwaltung* gives the results of a series of tests of the resistance of an Aveling & Porter steam roller. These tests were made by Herr VOIGES, at the request of Prof. SONNE, on about five-eighths of a mile of fresh macadam road near Ems. The roller weighed about 33,070 lbs., two-fifths of the weight being carried on the two front rollers and three-fifths on the two rear ones. The metalling of quartzite which was being rolled was only about 3 ins. thick. The resistances are as follows:

(*a*) 0.12 to 0.14, on loose, fresh layers of broken stone.

(*b*) 0.090 to 0.95, on partly compacted surfaces, such as result from the first third of the rolling.

(*c*) 0.075 to 0.80, at the end of the second third of the rolling.

(*d*) 0.065 to 0.070, when the rolling is finished.

(*e*) 0.080 to 0.090, when the surface has been sanded.

(*f*) 0.060 to 0.065, when the road has been covered with a well rolled and wetted layer of sand.

PERSONALS

MR. JOHN A. HOLLOWAY, contractor, of Buffalo, N. Y., died April 6.

MR. W. V. INGHAM has been elected City Engineer of Wilkesbarre, Pa.

MR. F. D. W. HOLBROOK, of Seattle, Wash., Manager of the Lake Shore & Eastern R. R., has resigned.

MR. SAM. HUSTON, Superintendent of the water-works at Oroville, Cal., for several years, died recently.

MR. CHARLES M. LEA, of Philadelphia, Pa., has been elected a Director of the Western New York & Pennsylvania R. R.

MR. RYAN has been appointed Superintendent of water-works at Salt Lake City, Utah, vice Mr. OTTINGER, resigned.

MR. GEO. W. HATTER has been appointed Superintendent of the Springfield Division of the Illinois Central R. R., vice Mr. WM. WILKINSON, resigned.

MR. JOHN J. CUNNINGHAM, has been appointed Superintendent of the Spring Brook Water Co., of Sandy Hill, N. Y., vice Mr. O. A. TEFFT, resigned.

MR. MIFFLIN PAUL, one of the original owners of the Camden & Amboy R. R., died recently at Red Bank, N. J.

MR. CHAS. W. MCMEEKIN has been appointed Chief Engineer of the Des Moines & Northwestern Ry., with office at Des Moines, Ia.

MR. JOHN C. CHASE, Superintendent and Engineer of the Clarendon Water-Works Co., Wilmington, N. C., has been appointed City Engineer of Wilmington.

MR. H. D. CAMPBELL, Secretary and Treasurer of the Pittsburg & Western R. R. Co., died at Allegheny, Pa., April 5.

MR. GEORGE PRESTON has been appointed Assistant Master Mechanic of the Ontario Division of the Canadian Pacific Ry., with office at Parkdale.

MR. J. D. YARRINGTON, Vice-President and General Manager of the Newport News and the Elizabethtown, Lexington & Big Sandy roads, has tendered his resignation.

MR. MARSHAL W. CARTER, a civil engineer who some years ago had charge of important operations on the Erie Canal and other public works in this State, died at Chicago recently.

MR. ROBERT LANG, of Hoboken, N. J., says the *Centralblatt der Bauverwaltung*, has been appointed an imperial government architect, Koeniglicher Regierungs-Baumeister, of Germany.

MR. HORACE LOOMIS, ex-commissioner of Street Cleaning, New York city, has returned to his former position as Chief Engineer of the Bureau of Sewers, in the Department of Public Works.

MR. F. W. D. HALBROOK has resigned his position as General Manager of the Seattle, Lake Shore & Eastern R. R., the resignation to take place May 1. The office will be abolished, its duties being assumed by A. S. DUNHAM, Managing Trustee. Mr. F. W. DUNN has been appointed Superintendent.

MR. J. A. FAIRLEIGH and Mr. R. D. BETTS, of Chattanooga, Tenn., have entered into partnership as civil engineers and contractors, to do business under the firm name of Fairleigh & Betts. MR. FAIRLEIGH has been City Engineer for 3 years, and Mr. BETTS, Assistant City Engineer for 3½ years.

MR. B. ANDREW KNIGHT, President of the Huntington & Broad Top Mountain R. R. Co., died at Philadelphia, Pa., April 4. He was for a number of years president of the Susquehanna & Tidewater Canal Co., and managed its affairs until it was leased by the Reading R. R. Co. MR. SPENCER M. JANNEY has been elected president, to succeed MR. KNIGHT.

MR. JOHN SCOTTI, the alleged inventor or introducer of the locomotive cab, is still living in Baltimore, Md., aged 70 years. The Baltimore *Sun* says he was one of the first engine-drivers on the Baltimore & Ohio R. R. In 1837 he made application for a covering that would afford him some protection in inclement weather, an innovation previously unknown and in fact prohibited. After considerable discussion permission was finally granted, and the first crude locomotive cab was built. In 1838, Mr. SCOTTI is said to have sounded the first locomotive whistle which was then applied to the engine "Andrew Jackson" as an adjunct to the bell previously used alone.

MR. H. B. STONE, Second Vice-President of the Chicago Burlington & Quincy R. R., has tendered his resignation, to take effect June 1. He retires from the railway business to become President of the Central Telephone Co. He has been occupied in railway work for 12 years, beginning his career in the mechanical department of the Burlington, of which he became Superintendent. In 1880 he was made Superintendent of the locomotive and car departments. The next year he became General Superintendent of the road, and later attained the offices of Assistant General Manager and General Manager.

PUBLICATIONS RECEIVED.

—*Annual Report of the Board of Water Commissioners of the City of Manchester for the fiscal year ending Dec.* 31, 1889. Pamphlet, 31 pp. CHAS. K. WALKER, Superintendent.

This report also includes classified list of consumers.

—*City of Dover (N. H.). Second Annual Report of the Water Commissioners for the municipal year* 1889. Pamphlet, 68 pp. CHAS. A. FAIRBANK, Clerk.

The report quite fully describes these new works. A classified list of consumers is given, and also side and end views of the Blake pumping engine.

—*Seventeenth Annual Report of the Winchester Water Board.* March, 1890. Pamphlet, 16 pp.

Besides the usual matter this report contains a record by months and years of the rainfall in the vicinity of Winchester for the years 1875 to 1889. W. T. DOTTEN, Superintendent; ALBERT AYER, Water Registrar.

—*Annual Report of the Superintendent of the Richmond, Va., City Water-Works to the Mayor of the City for the fiscal year ending Dec.* 31, 1889. Pamphlet, 56 pp. C. E BOLLING, Superintendent.

Monthly pumping records are given and also an interesting table comprising the report of inspectors from May 1 to Dec. 1, 1889.

—*Seventeenth Annual Report of the Water Commissioners of the City of Fitchburg, Mass.*, 1889. Pamphlet 34 pp. THOS. C. LOVELL, Superintendent; A. W. F. BROWN, Water Registrar.

A summary of statistics, in accordance with the suggestions of the New England Water-Works Association, is given, together with classified list of consumers and water receipts and maintenance for each year from 1872 to 1889, and analyses of water taken from the three reservoirs.

—*Seventeenth Annual Report of the Board of Water Commissioners of the City of East Saginaw, Mich., for the year* 1889. Pamphlet, 63 pp. HENRY M. NEWTON, Secretary.

Some interesting meter and pumping statistics are given, also statistics for each of the years 1873 to 1889, including consumption of fuel, yearly and daily average pumpage, number of fire calls, hour of pumping for fires, total yearly cost of maintenance and cost per million gallons, and revenue from consumers.

—*City of Poughkeepsie (N. Y.). Twenty-first Annual Report of the Water Commissioners for the Year* 1889. Pamphlet, 22 pp. CHAS. E. FOWLER, Superintendent.

Analyses of water, before and after filtration, made by Prof. T. M. DROWN, Boston, Mass., are presented. The cost of filtration for the year 1889, excluding total of $180 for repairs, was $1.75 per 1,000,000 galls. Total amount filtered, 572,000,000 galls. A classified list of consumers is given, as also number of taps and total number of gallons pumped for each year from 1873 to 1889.

—*Connecticut Association of Civil Engineers and Surveyors.*—Report of meetings of September, 1889, and January, 1890; 37 pp.

The following papers, with discussions thereon, are contained in this number: "Earth Dams," H. W. Ayers; "Dam of the New Haven Water Co." L. A. Taylor; "Heating Passenger Cars," W. E. Pettee; "Farmington Water Works," A. R. Wadsworth; "The Care of Sewers," F. Floyd Weld. There are also reports of committees on "Legislation for Dams and Reservoirs," "Sewers," and "Water-Works."

TRADE PUBLICATIONS.

Astoria, Ore.—A pamphlet of 34 pp. containing reprints of various newspaper articles and comments on this city and its prospects.

Duplex Steam Pumps.—Advance sheets from the new illustrated catalogue of the Barr Pumping Engine Co., of Philadelphia, Pa.

Engineering Works.—Pamphlet, 13 pp., issued by Nier Hartford & Mitchell, engineers, of Chattanooga, Tenn. and Kansas City, Mo., showing the work undertaken by the firm.

—Culvert Pipe; 9x6 ins.; 36 pp. Blackmer & Post St. Louis, Mo.

Illustrated pamphlet and price list, containing a description of the manufacture of the pipe and of its various uses for highways, railways, etc. Also instructions for laying.

Kalamazoo Railroad Velocipede & Car Co.—Kalamazoo, Mich. Size, 9⅛ × 7¼ in. 32 pp.

Illustrated pamphlet and price list of various kinds of velocipedes, etc., for track work and inspection. The inspection cars, built of steel, are very light and handy The ordinary section cars are of wood, with wood and paper wheels. One of the most interesting of these machines is a steam inspection car, weighing 850 lbs. The pamphlet contains a list of over 130 railways on which the company's cars are in service.

—Tramway Motors and Steam Cars.—Illustrated catalogue of the Baldwin Locomotive Works, Philadelphia Pa. Cloth. 7¼ x 10½ ins.: 24 pp.

This is a well got up and finely printed catalogue, containing much information on the question of steam motors for street railways. Such motors are said to be now in use on nearly 75 city and suburban lines. Tables are given of the size, weight, hauling power, etc., of engines of different classes. There is also an interesting table of results in service, giving particulars of the engines, trips and cost of operation. It is stated that the separate motor will in most cases be found preferable, but that there are cases where the steam car may be found to possess advantages over the separate motor. The Baldwin Locomotive Works have built numbers of engines of both kinds for home and foreign lines, and their performance has been very satisfactory.

SOCIETY PROCEEDINGS.

Civil Engineers' Club of Cleveland, O.—At the meeton April 8, President Searles in the chair, the President announced the receipt of a communication from the Committee of the American Society of Civil Engineers, inviting a committee of conference on the question of affiliation between that Society and the Club. A motion was made to refer the matter to a committee, which, after some discussion, was passed.

A paper was read by Mr. Ambrose Swasey on "The Eiffel Tower, from Foundation to Lantern," which was illustrated by a number of large diagrams and a large model of the tower. C. O. PALMER, Secretary.

Engineering Association of the Southwest.—Regular meeting April 12, held at the Galt House, Louisville, Ky., President John McLeod, presiding. The first paper read was by Mr. Charles Hermany, Chief Engineer of the Louisville Water Works, on "Excavation under Pneumatic Pressure." No detailed report of this interesting paper is available, though it is understood that much of the paper was devoted to a description of the O'Conner dredging bucket, first used at Pier 4 of the Henderson bridge, over the Ohio, in connection with pneumatic caissons. Mr. R. H. Engle, Engineer of the Louisville & Jeffersonville bridge, next read a paper on the foundations of the new bridge. He gave the principal dimensions of this bridge as follows: Length of bridge, 2,545 ft.; Jeffersonville approach, 4,073 ft.; Louisville approach, 2,740 ft.; total, 9,358 ft. The bridge will have seven river piers, with a single railway track and two footways. Prof. Landreth read extracts from a paper on the condition of cement when set at once and delayed in setting. Excursions were made to the New Albany bridge, the tornado-swept district, the water-works, the Louisville Southern high bridge, and other points of interest.

Liverpool Engineering Society.—A meeting of this Society was held March 26, Mr. Henry H. West. M. Inst. C. E., President, in the chair.

A paper was read by Mr. Thomas L. Miller, Assoc. M. Inst. C. E., M. I. M. E., on "The Efficiency of Gas Engines." In opening the paper the author referred to the practice of stating the efficiency of gas engines in terms of the gas consumption per horse-power per hour, without any reference to the thermal value of the gas used, and showed, from a comparison of the calorific value of the gas in different districts, how unfair such a practice was when the efficiency of engines tested in different localities was so compared. An explanation of the different senses in which the term "efficiency" was used in the paper was then given, after which the author proceeded to explain the system of classification of gas engines adopted by Mr. D. Clerk, the theoretical efficiency of the various types being given.

The causes of loss in the gas engine were then referred to in detail, and the means by which such losses might be reduced explained. The experiments of Messrs D. Clerk and G. C. Douglas on the explosion of gaseous mixtures were then touched upon, and the various theories advanced to account for the suppression of heat at the moment of ignition were dealt with. A discussion of the more important tests on gas engines then followed; the absolute amount of heat supplies for the engines per H. P., together with their efficiency, being given. The Harreaves motor was then referred to, and its method of working explained, and a comparison was made between the results of tests with this engine and those of the most economical gas engines mentioned.

The author concluded the paper with a comparison of the efficiency of the gas engine with that of the steam engine, in the course of which he pointed out that while the gas engine had the advantage from a thermo-dynamic point of view, the high price of its fuel soon placed it at a disadvantage, as with coal gas at 75 cts. per 1,000 cu. ft. and coal at $3.75 per ton, the gas engine with a consumption of 20 cu. ft. of gas per I. H. P. per hour was just equal in cost of fuel to that of a steam engine indicating one H. P. per hour for a consumption of 9 lbs. of coal.

Engineers' Club of Philadelphia.—Meeting April 15 1890. President H. W. Spangler in the chair; 18 members and 2 visitors present.

The Secretary reported the special meetings of the Board of Directors and Past Officers to take action with regard to the death of Mr. Frederic Graff. It had been ordered that his portrait be appropriately set on an easel and draped in mourning for thirty days, and that flowers be added to the drapery on meeting night. An appropriate announcement was ordered.

The Secretary presented, for Mr. Frank Cooper, Notes on Railroad Engineering Drawing. The author treats of kinds of drawings required, paper, tracing cloth, inks, tinting, lettering, plotting topography, scales, railroad curve patterns and filing drawings.

There was some discussion by Messrs. Brown, Rondinella and Murphy.

Mr. E. H. BROWN stated that it was the practice in his office, instead of making drawings on paper and then tracing them upon linen, to use smooth surface Crane's band paper, which comes in sheets of various sizes. The drawings are made in pencil on this, and when correct are inked in at once, avoiding any chance of errors arising from the tracing linen slipping after a tracing has been begun. Blue prints are made directly from the finished drawings, requiring, with a moderately sensitive paper, from seven to eight minutes to make a print in bright sunlight. This method of making drawings not only saves the time usually required in making the tracing, but is a considerable saving of expense, as linen is by no means an inconsiderable item in office expenses.

Mr. E. S. Crawley described a new form of steam valve, in which packing is used instead of a ground seat. He exhibited a model and drawings. There was some discussion by Messrs. Morris, Spangler and Murphy.

HOWARD MURPHY, Secy. and Treas.

American Society of Civil Engineers—The annual convention will be held at Cresson, Pa., on the line of the Pennsylvania R. R., on the western slope of the Alleghany Mountains. Cresson is between Altoona and Johnstown. There is a large hotel managed under the direction of the railroad company. Arrangements are in progress as to all details, which will soon be announced The date will be near the end of June; the exact day will also be announced. Members are invited to contribute papers or discussions on papers already published. A concise abstract of any paper to be presented should be sent to the Secretary not later than May 31. This will make discussion more probable, as a copy of the abstract will be sent to members who may be expected to contribute discussion. JOHN BOGART, *Secretary*.

The regular meeting was held April 16, Vice-President A. Fteley in the chair.

A letter from Mr. Wm. Metcalf was read, giving some account of tests of steel bands. The subject will be presented more fully for discussion at the convention.

The results of some tests of cement from the Rosendale Valley and central New York, made with special reference to the strength of mortars as compared with neat cements, were presented by Mr. John Bogart. He considered that better results were obtained with 1 part cement to 1 part sand (crushed quartz sand) than with neat cement. The cement was mixed to the consistency of stiff mortar, pressed into the mold with the trowel but not tamped. It was pointed out by Mr. Bogart and by others during the discussion that the practice of making systematic tests, and enforcing the requirements that the cement must come up to a specified standard, resulted in a better and more uniform quality of cement being furnished by the manufacturer; while the inferior qualities would be sold to purchasers who do not keep up a rigid system of testing.

Mr. Cooper considered that averages of tests were in many cases of little value, as they might be affected by results obviously incorrect. If the maximum, minimum and average were given, it could be seen at a glance whether the latter were to be relied on. Mr. Emery referred to the form of briquette having parallel sides for a length of about 3 ins., with enlarged ends for the clamps, and considered it better than the ordinary standard form in certain cases. Mr. Crowell and Mr. Brendlinger referred to the desirability of carrying out a series of tests, and to the fact that this is not generally recognized by railway officials. Mr. Brendlinger described a cement-testing machine he had made when a railway company had refused his requisition for a machine; he stated that the results obtained had convinced that company of the usefulness of such apparatus, and that engineers on new work were now furnished with good testing machines.

New England Railroad Club.—At the meeting on April 9 a paper on Locomotive Boilers was read by H. L. Leach.

In general design the locomotive boiler of the present day is like the boiler of some of the first successful locomotives constructed. In determining the form of the boiler, provision for expansion and contraction and free circulation, the arrangement of parts to resist the internal pressure, and the securing of perfect combustion of the fuel are the essential points.

Assuming all locomotive boilers to be made of steel, care should be taken in flanging that the plates are not over heated. All holes in boiler plates should be punched, especially all flanged plates. Cracks occur more often at rivet holes in a flanged plate than anywhere else. If holes are punched care should be taken to keep punches and dies sharp. If the corners are worn rounding the plate is weakened much more than if the punch and die are sharp. A punch and die should be in such a condition that no depression can be observed around the rivet hole. No drifting should be allowed in boiler work.

The re-enforcement of the longitudinal seam by a welt is a great improvement, not only strengthening the boiler but preventing corrugation. All plates should be thoroughly annealed after working, especially all flanged plates. It has been a frequent practice in the past to make the back end of three plates, one on each side extending up to the circular part, and the third forming the crown. Furrowing is very likely to occur where the side plates join the outer crown plate, and it cannot be inspected without taking out the fire-box. It is therefore recommended to make the back end of a single sheet, avoiding these seams at this dangerous spot.

The circulation is an important feature in securing economy and durability.

The throat plate should have as large a circle as possible, the water space in front of the fire-box should be ample to admit a large and easy flow of water, and the flues should not be too near the shell. The greatest heat, and consequently the most rapid flow of water in the cylinder part of boiler is in and around the flues nearest the center, and as that flow must be upward, a space should be left somewhere for the water to descend, and the descent should be at the coolest part. It is impossible for the water to descend around the fire-box, on account of the rapid upflow, owing to the extreme heat in the box, and as the outside of the barrel is naturally the coolest place plenty of space should be left there for the down-flow.

It is often asked how old a boiler should be before it is condemned. The safety of a boiler does not depend so much on its age as on the material of which it is built. All locomotive boilers, nowadays, are built of steel, and though many good boilers have been made of iron, it is now generally admitted that steel is better than iron for this purpose. There is a greater variation in the quality of steel than of iron. Reworking iron improves it, but this is not the case with steel. Plates made partly or wholly from remelted or scrap steel should not be used for boilers.

Mr. Mack described a stationary boiler of locomotive type whose working was much improved by putting in circulating pipes, extending from the bottom of the cylindrical part to the bottom of the water space around the fire-box.

President Richards described an old locomotive boiler built in Liverpool at the works of Edward Bury in 1836, which was in use until the present decade. He alluded to the fact that furrowing was less common nowadays when a locomotive was not cooled off oftener than once a week, than in the early days of railroading, when steam was dropped whenever the locomotive was out of service.

Mr. Lauder commended the plan of making the outside crown sheet in one piece and also the cylinder part of the boiler with a single longitudinal seam. He had had excellent results from the use of a double riveted mud ring and recommended it highly. For roads which have to use bad water he favored the Belpaire fire box.

In putting in longitudinal stays, many builders run them from the head to the shell of the boiler, and rivet them instead of running them straight through. This he strongly condemned.

He expected to see locomotives carrying 200 lbs. steam pressure within five years.

At the next meeting the subject for discussion will be "The Length of Rigid Wheel Base Permissible on American Railroads."

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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ASSOCIATE EDITORS.

GEO. H. FROST.....BUSINESS MANAGER

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Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia, Pa.—Next meeting, April 19. Secy., Howard Murphy, 1122 Girard St.

Western Society of Engineers, Chicago, Ill.—Next meeting, May 1. Secy., J. W. Weston, 230 La Salle St.

Civil Engineering Society (Mass. Inst. of Technology), Boston, Mass.—Next meeting, May 1. Secy., Clement March.

Association of Civil Engineers, Dallas, Tex. Next meeting, May 2. Secy., E. K. Smoot, Elm and Austin Sts.

Civil Engineers' Society, St. Paul, Minn.—Next meeting, May 5. Secy., Geo. L. Wilson, City Hall.

Engineers' Club of Kansas City, Mo.—Next meeting, May 5. "The Evolution of the Elevator," R. M. Sheridan. Secy., Kenneth Allen, 200 Baird Building.

Civil Engineers' Club, Cleveland, O.—Next meeting, May 6. Secy., C. O. Palmer, 22 Cedar Ave.

Engineers' Club of St. Louis, Mo.—Next meeting, May 7. "Compound Locomotives," A. T. Woods; "Granitoid Curb and Gutter," Otto Schmitz. Secy., W. H. Bryan, 309 So. 7th St.

American Society of Civil Engineers, New York.—Next meeting, May 7. Annual convention, at Cresson, Pa., in June. Secy., John Bogart, 127 E. 23d St.

Engineering Association of the Southwest, Nashville, Tenn.—Next meeting, May 8. Secy., Olin H. Landreth, Vanderbilt University.

Civil Engineers' Association of Kansas, Wichita, Kan.—Next meeting, May 14. Secy., J. C. Herring, Wichita.

New England Railway Club, Boston Mass.—Next meeting, May 14. "Length of Rigid Wheel Base Permissible on American Railways for Locomotives, Tenders or Cars." Secy., F. M. Curtis, Old Colony R. R. Rooms in the United States Hotel.

New York Railway Club.—Next meeting, May 15. Rooms, at 113 Liberty St.

American Water-Works Association.—Annual meeting at Chicago, Ill., May 20. Secy., J. M. Diven, Elmira, N. Y.

Western Railway Club, Chicago, Ill.—Next meeting, May 20. Rooms in the Phœnix Building. Secy., W. D. Crosman.

Engineers' Society of Western Pennsylvania.—Next meeting, May 20. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, May 21. Secy., S. E. Tinkham, City Hall.

Master Car-Builders' Association.—Annual convention at the Hygeia Hotel, Fortress Monroe, Va., June 10. Sec., J. W. Cloud, Buffalo, N. Y.

American Railway Master Mechanics' Association.—Annual convention in June. Sec., Angus Sinclair, 140 Nassau St., New York.

THE Annual Convention for 1890 of the American Society of Civil Engineers, will be held at Cresson, Pa., about the end of June. The exact date has yet to be announced. The meetings will be doubtless held in the large hotel managed under the direction of the Pennsylvania Railroad Company. Cresson is on the Pennsylvania Railroad, between Altoona and Johnstown. No programme of visits to works of interest has yet been published, but one is now in preparation.

HIGHWAY bridge inspection legislation, which shall insure some reasonable amount of care and skill in the design of such bridges is admitted by all engineers to be an urgent necessity, and a number of prominent engineers in St. Louis and Kansas City have been for some time laboring to obtain legislation which shall secure this, with the result which appears in another column, in the form of a proposed bill. It provides in substance for the appointment by the governor of an indefinite ("sufficient") number of "bridge experts," living in any part of the globe, from among whom highway bridge engineers and inspectors shall in all cases be chosen. These experts are to pay $100 and $25 per year for the privilege of appointment, and "satisfactory evidence from other skilled engineers" of competency is all that is required. The fees are to be "not more than $25 per day" and 4 cents per mile mileage; fees which the more expert of bridge engineers would not think of accepting, much less of paying $25 per year for the privilege of having a chance to accept. The practical effect of the bill, we think, would be the appointment of a host of second-rate and third-rate men, while the tendency would be strong for some bridge companies to have two or three experts of their own in the list who would be pushed forward on all occasions. There would also be under the provisions of the bill, a general still hunt for chances to inspect old structures, which can be ordered by any county court. We are not now prepared to suggest a better bill, but it appears to us that this bill at least needs amendment. It would surely tend to throw the work of bridge inspection into the hands of second-rate place hunters. A certain age, and a certain number of years practical experience should at least be required before a man could be appointed an expert, and we are disposed to favor having the "experts," in the public interest, a strictly limited body of from one to five persons, appointed for a short term of years only and not practically for life.

THE recent disastrous floods on the Lower Mississippi have directed attention anew to the great and difficult engineering problem which confronts the country in the control of the turbulent "Father of Waters." The policy now being pursued is the construction of levees by the States bordering the river. Millions of dollars have been expended on these embankments, and yet in every great flood the river breaks through its barriers and overflows extensive tracts, causing enormous destruction of property and and often of life.

Why the present levee system was so impotent a barrier against great floods was plausibly explained by Prof J. B. JOHNSON in a paper read six years ago before the Engineers' Club of St. Louis, which we republish, considerably condensed, in this issue. The facts, as stated by him, are simply these Instead of the lower Mississippi being a single stream, as is generally supposed, it is a labyrinth of bayous, river channels and swamp basins, 20 to 100 miles wide, with the main channel of the river winding a tortuous course through it. When the river is low the flow is confined to the main channel. At the time of flood the river is left to itself, spreads over the bottoms, and at places not more than half the flow is carried in the main channel. To attempt to confine all the water of a flood to the main channel, therefore, as the levee builders propose, will necessitate an embankment from Cairo to the Gulf, he claims, far higher and more expensive and massive than anything yet built or contemplated.

Whether his views are in all respects correct or not, Professor JOHNSON'S paper is a valuable contribution to the discussion of a problem with which members of the engineering profession in the East are not too familiar, but whose correct and economical solution, if effected, will be one of the greatest achievements of American engineering.

WE publish in another column a record of some very interesting experiments on the effect of time in tests of iron and steel. It is quite certain that time allowed for flowage of the particles of metal on each other has a most important influence on the behavior of metals under strain in certain cases. In wire drawing, for example, the rate of speed has to be very carefully graduated to the size and kind of material to avoid rupture. If drawn too fast the wire will either check or break. The same influence is generally believed to have an important effect upon the quality of rails, and there is much evidence in support of this view. If the rolling be slow, the particles of metal have adequate time to readjust themselves to the reduced section, and the product is as homogeneous as before, and more compact. If rolled too fast, we do not know that there is positive evidence of the specific gravity being ever reduced, but there certainly is ample evidence that a punky, uneven, striated metal often results, which bears no resemblance to good steel in its fracture, although the same metal more carefully worked, will show most excellent qualities. It is also quite certain that metal subjected to sudden strain does not necessarily break at its weakest point. A certain *time* is necessary for the transmission of strain—how much and according to what laws is most imperfectly determined—so that a long bar subjected to sudden strain at one end is likely to break near that point, though there may be a weaker and more remote point where the fracture would occur under the same strain more gently applied.

FOR these reasons we should naturally expect that very material differences would result from variations of speed so great as to be in the ratio of 1 to 27½, as was used in the experiments recorded elsewhere, especially in the items of elongation, reduction of area, and ultimate strength. Such did not prove to be the case. There is a difference, but it is for the most part small. The elongation seems almost independent of speed. The reduction of section is more affected, but still not greatly affected. The ultimate strength is considerably affected, most noticeably in the harder steels. The elastic limit presents a curious anomaly, for which we refer to the paper itself, which may or may not be accidental.

The experiments are more than fairly consistent with each other, almost suspiciously so; a series of "questions put to nature" rarely results in so little conflict of evidence. We suspect, however, that, could the experiments have been continued to still higher speeds, the results might have been vastly more marked, and the effects of speed very important indeed. For, although the range in ratio of speeds (1 to 27½) is very considerable, yet all these speeds are very slow compared with the rate at which many like strains are applied in practice, ranging only from 0.16 to 4.40 ins. per minute, or from 0.002 to 0.073 ins. per second. Increase these speeds five or ten-fold, and we should expect with some confidence to find that the table elsewhere given only shows the beginnings of a tendency which would increase in geometric ratio, and perhaps show a marked reduction in elastic limit. There are difficulties which we fully appreciate in making accurate tests at such high speeds; but he who first makes them

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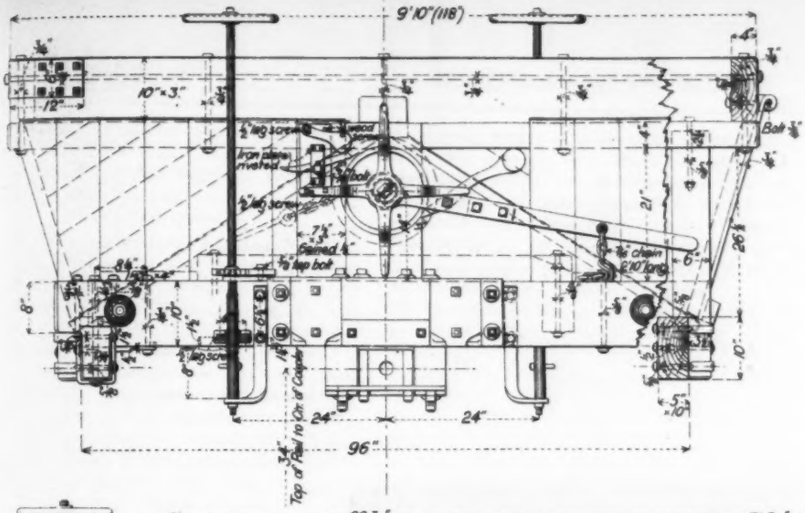

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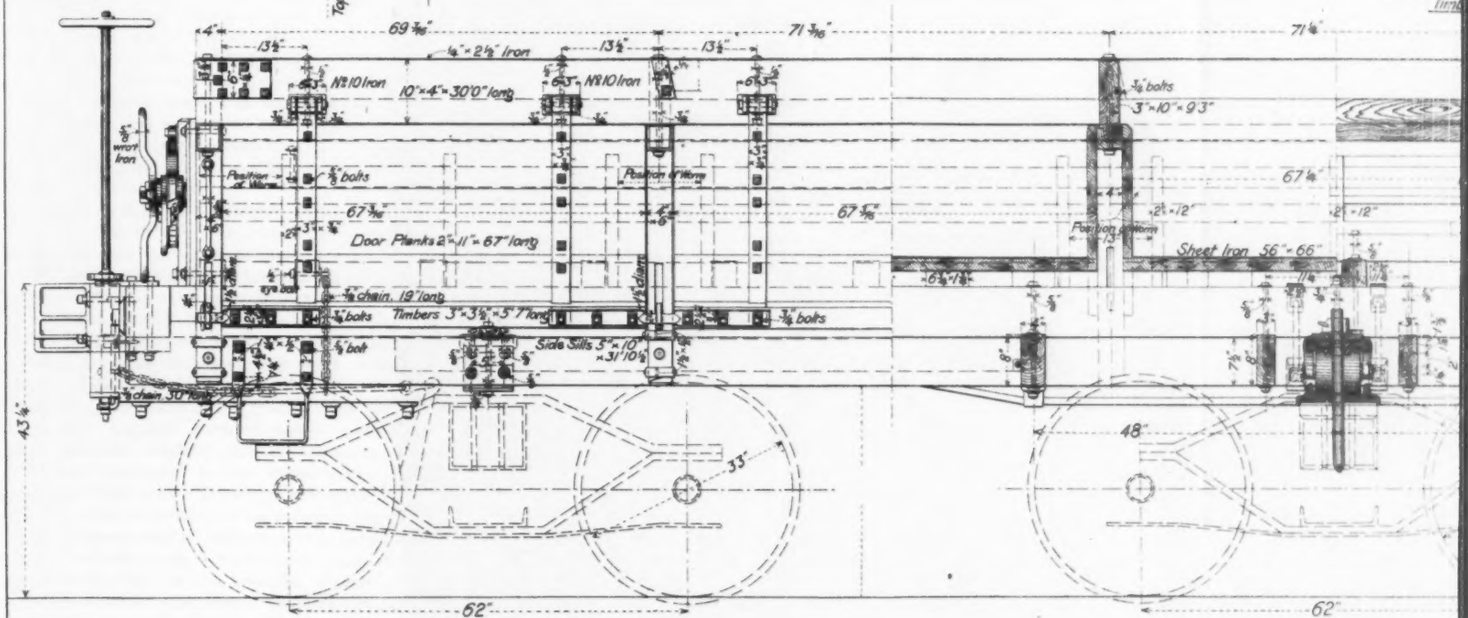

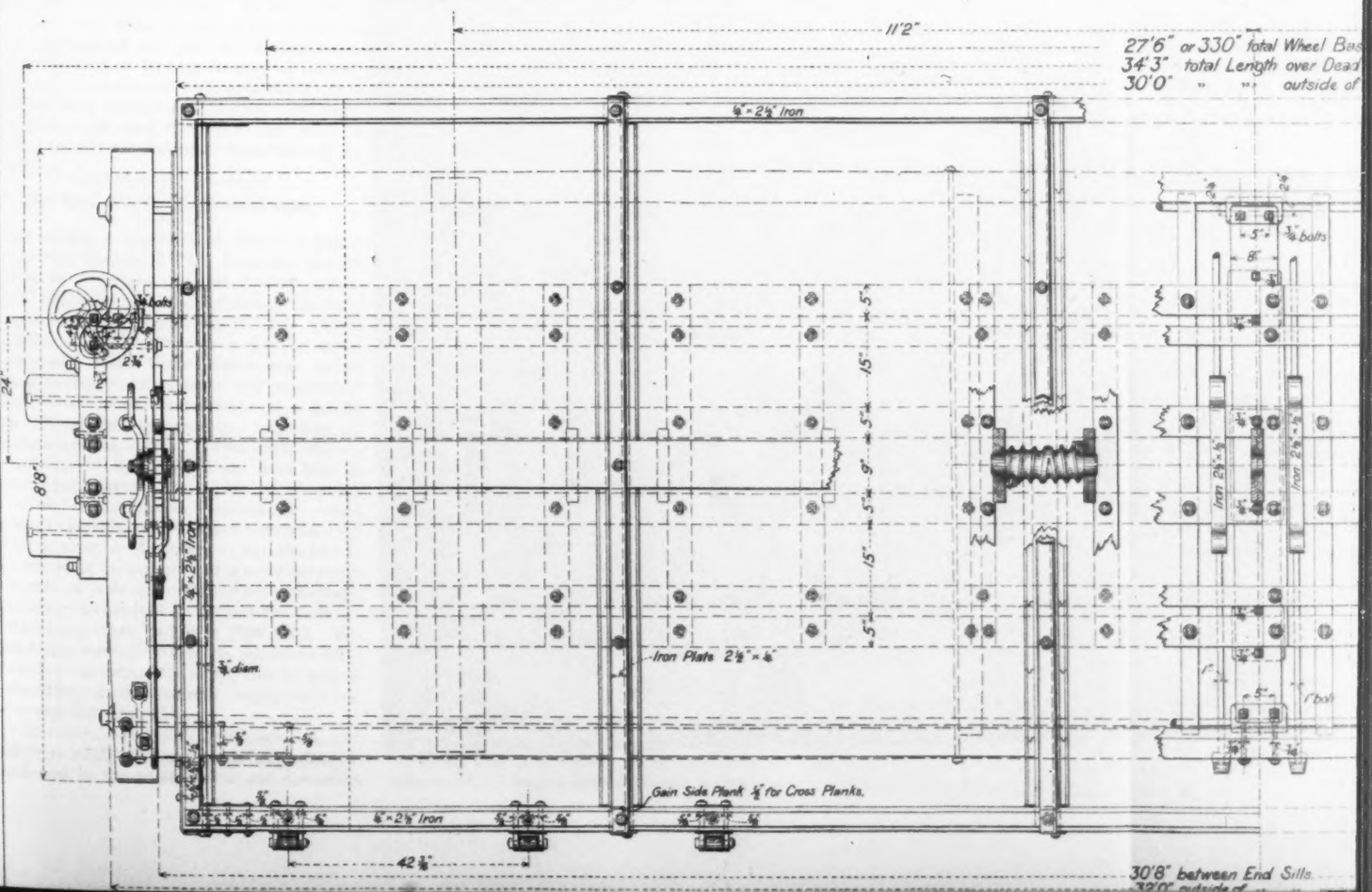

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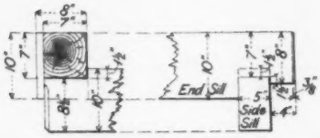
OSS KELLS, SUPT. OF MOTIVE POWER.

Framing of Side Posts.



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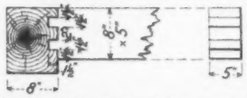
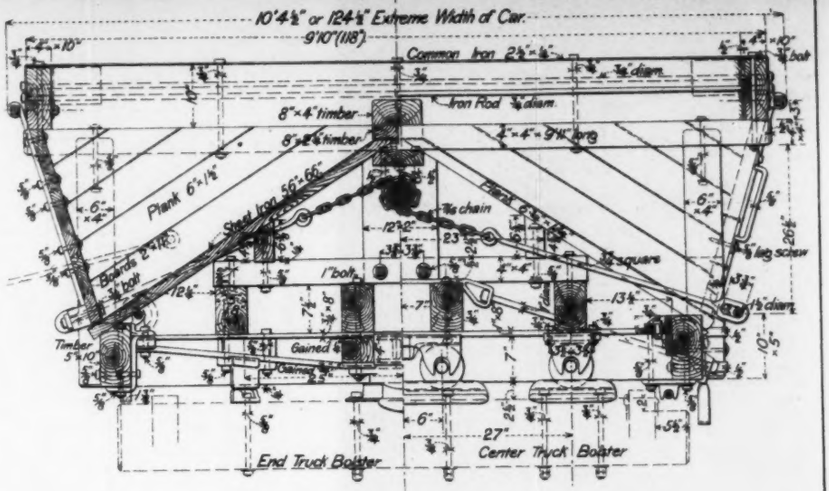
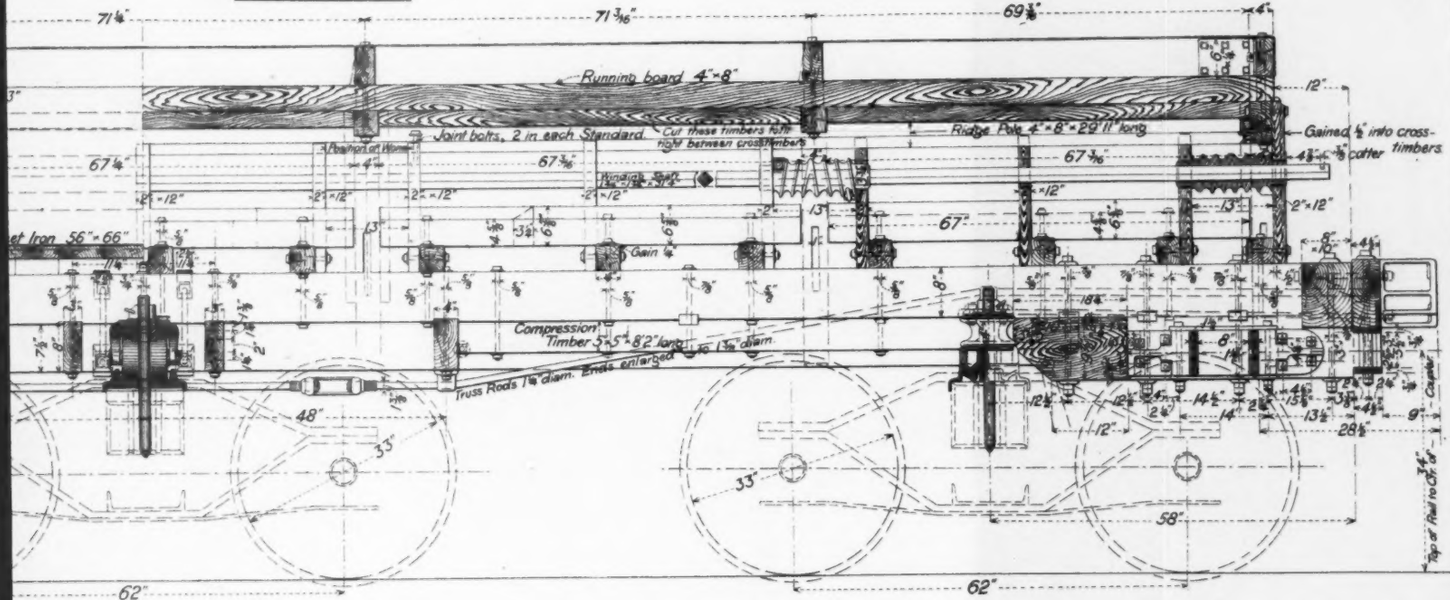
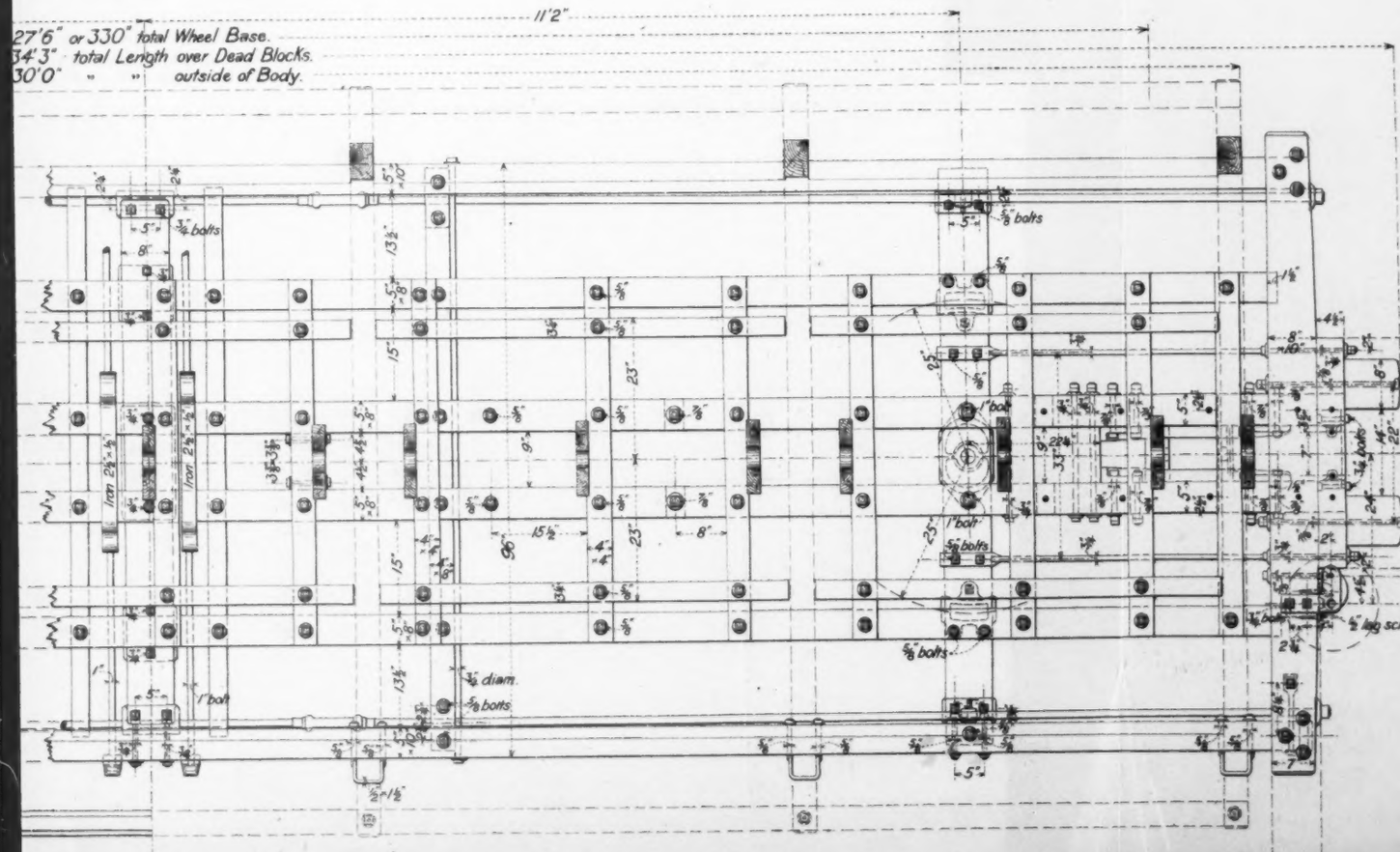


Framing of Central and Intermediate Timbers into End Sills.




Running board 4"-8"
Joint bolts, 2 in each Standard.
Cut these timbers to fit right between cross timbers
Ridge Pole 4"×8"-29'11" long
Gained ½" into cross-batter timbers
Compression Timber 5"×5½"-8'2" long to 1⅜" diam.
Truss Rods 1⅛" diam. Ends enlarged
48"
33"
62"
58"



will make a real contribution to knowledge, which might bear important fruit. They ought to be made to include the widest range of probability in quickness of applied strain.

THE New Croton Aqueduct contractors' bill asking for the appointment of a commission or board to settle disputes as to the cost of repair of faulty work, the interpretation of the contract, etc., has passed the State Senate, and is now before the Cities Committee of the Assembly. A precedent is here sought to be established that may work much present and future harm, and we are not surprised at the vigorous protest of the Aqueduct Commissioners, the Mayor, Corporation Counsel, City Comptroller and the Public Works Commissioner of New York against its passage. This work belongs to New York City alone; it is to be paid for by the city, and it is a matter that should be settled in the regular courts of this State, according to well defined rules of practice. This disposal of the case cannot be otherwise than just and fair to both parties. Before such a court all valid expert evidence is admissible, and the case can be decided upon its merits alone, and according to the evidence and established law.

The submission of the evidence to a board changes the law in the case, invalidates future contracts between corporations and individuals powerful enough to change the law, and opens the door to corruption in the appointment or actions of the referees. If this bill passes, all future contracts for public works are practically valueless as an index of the probable cost of such works. The existence of bad work is not disputed, the only questions are, who is legally responsible for it, and whether the original contract covers certain changes from the original plans made necessary by conditions uncovered in the natural course of the progress of the work. These are, first and last, legal questions to be decided by lawyers and judges and not by laymen; and if questions of fraud or bad faith enter into the case, a jury, under legal advice and in the light of the evidence presented, can again settle this better than a board appointed most probably on partisan lines. We always have and always will labor to protect the contractor against injustice on the part of corporations, or against blunders or laxness in duty on the part of engineers; but this bill would establish a precedent more likely than otherwise to do harm to all parties concerned, and it is from this point of view that we add our protest to those already referred to.

The Am. Soc. C. E. Transactions.

When the list of members of 1889 was issued the American Society of Civil Engineers had 979 Members, 50 Associates and 138 Juniors, and including Honorary and Corresponding Members and Fellows, a total membership of 1,257. In this association of the best known and most active civil engineers in the United States there should certainly be sufficient experience and professional interest to secure the presentation of a goodly number of carefully prepared and important papers on engineering topics. Yet for three consecutive meetings of the society there have been no papers for publication. There have been interesting "talks," which proper presentation would have made valuable, and reports of tests which are valuable as a matter of reference; but the former is not just what is expected of a technical body, and reports of tests are certainly not sufficiently interesting in themselves to attract the audience that the society could gather in New York. The matter becomes serious when the persistent effort of the governing body of the society, for we assume that the effort is made, can only supply such material as that last referred to.

The American Society of Civil Engineers cannot afford to stand still, and much less afford to go backward, in the presentation and discussion of the many works of engineering interest going on in this country, in a manner worthy of its name and standing. As its members are known to the world by their deeds, so this Society will be known and judged by its published transactions, which are, after all, the truest index of its value as an engineering association and of the interest taken in its welfare by engineers.

It is not an agreeable task to point out what seem shortcomings in the oldest of all of our engineering societies, but we feel that this matter of society papers is too vital and important to pass by. The members need prodding; and while we hope that the officials of the society are doing their full share of this irksome but necessary task, we do not believe that outside effort can result in harm. The proceedings of similar foreign bodies fill bulky volumes, and with our national activity in public works we should at least do as well in proportion to our membership, and can do better if our engineers will. We recognize the fact that engineers as a class are not given to literary effort, and the busy nature of their profession may be offered as a valid excuse; but polished figures of speech are not expected nor wanted in the class of papers really valuable to such a society. The engineer is not worthy of the name who cannot find in his work some experience that would be useful to his fellow engineers, and his work would be very commonplace, indeed, if a clear, unvarnished detail of its trials, failures, and successes were not acceptable and professionally of value to the members of the Society. Daily contact with work may sometimes make an engineer oblivious to its common value to the profession, and in such cases it should be the duty of the Society to remind the engineer of what is really an obligation to his fellow members, and to persistently labor with him until his success or his failure for cause are made a matter of record. Without this watchful care over the deeds of engineers everywhere, the Society fails in one of its chief duties, and its members will lose many valuable contributions.

How this end can best be accomplished we will not now discuss, especially at a time when the laws of the society are in the hands of a committee for revision. But we feel that we can not too strongly urge upon this committee the careful consideration of radical improvement in the methods of gathering papers for presentation, discussion and publication. The very life and continued usefulness of the society depends upon the character of work performed in this direction; and this is especially the case with non-resident members who have little but professional pride in the society and the professional value of its published transactions to bind them to it at all. The fact that local engineering societies are fast multiplying, and have their own meetings and their own vehicles of publication, has undoubtedly a marked effect upon the decrease of papers presented to the parent society. But this is a state of affairs that can only be remedied by making the older society so active among engineers, and by extending its influence to such a degree, that every engineer will feel that his first duty lies there, and that the first fruits of his experience belong to it by right and preference. The society must be more active, alert and even aggressive, if it is to continue, in fact, what it is in name, the American Society of Civil Engineers.

The Bridge Failures of Eleven Years.

In our issue of March 30, 1889, we summarized "The bridge failures of ten years," using as a basis a statement prepared by Mr. CHAS. F. STOWELL, bridge engineer of the New York State Railroad Commission, similar to that for 1889, and for eleven years, which appears in another column. From this latter statement we are now able to summarize the bridge failures for one year more. Such a summary, moreover, can now be better understood than ever before, through the labors of Mr. THEODORE COOPER, a part of whose paper on "American Railroad Bridges," relating to the total number of bridge spans in the United States, we reprint in another column. From this record we abstract the following estimated totals of spans and miles of bridging in the United States, which makes it possible to see how small a portion it is of our enormous aggregate of bridges which fails in service.

Estimated Total Iron and Wooden Bridges in the United States.

Span in Feet.	Number of Spans.			Miles of Bridges.		
	Iron.	Wood and combin'n.	Total.	Iron.	Wood.	Total.
20 to 50.....	12,900	5,250	18,150	86	35	121
50 to 100.....	4,600	4,500	9,100	66	64	130
100 to 150.....	3,900	4,100	8,000	93	97	190
150 to 200.....	2,100	1,200	3,300	69	40	109
Over 200.....	950	200	1,150	49	7	56
	24,450	15,250	39,700	363	243	606
Trestles and spans under 20 ft.....	5,100	722,100	727,200	17	2,407	2,424

[Elevated railway mileage and structures not included.]

In comparison with this enormous aggregate of bridging, which should always be remembered in considering American bridge failures, we have the following record of iron bridge failures from all causes for the two years, 1888–9.

	20-50'.	50-100'.	100-150'.	150-200'.	Over 200'.	Unk'n.	Total.
1888.	1	..	3	1	..	1	6
1889.	1	..	3	..	..	1	5
Total	2	..	6	1	..	2	11

Nearly all of these, as we shall shortly see, were knocked down by derailed trains, or otherwise failed without reproach to their designers, and keeping all these contingencies in view the number cannot but be regarded as moderate under all the circumstances, being only one failing yearly from all causes out of 4,446 iron bridges. For wooden bridges the record is not quite as gratifying, but is as follows, failures *from all causes* being included, and all bridges of unreported material being classed as wood:

	20-50'.	50-100'.	100-150'.	150-200'.	Over 200'.	Unk'n.	Total.
1888.	..	3	2	2	1	17	25
1889.	3	4	1	..	..	9	17
Total.	3	7	3	2	1	26	42

This shows a total of one failure *from all causes* per year for every 728 wooden bridge spans, there being about four times as many wooden as iron bridge failures, while there are only about two-thirds as many wooden as iron bridges of over 20 ft. span remaining, according to Mr. COOPER'S figures, which, by the way, we cannot help suspecting in this item, since the number of wooden spans remaining is still very great. The estimate seems to be a careful one, however, and is at least as near to the truth as we are likely to get very soon. We estimated last year, in the article referred to, that not over one-third of our truss bridging was yet iron.

To see what these figures mean, let us examine in more detail the failures for the past year. The iron bridge failures were five only (Nos. 2, 3, 6, 10 and 12 of Mr. STOWELL'S list), the first one, moreover, being a Canadian bridge, and so not properly included with American bridges.

Of these five failures *all but one* were due to impacts from derailed trains, a danger which, it should be carefully noted, can be reduced to a minimum, and wholly prevented in a majority of cases, by inexpensive precautions at the end of the bridge in the way of guard-rails, rerailing frogs and collision posts. The remaining failure (No. 6) was due to the washing away of a temporary wooden pile abutment, so that there is not a single instance during the past year of an iron bridge failing from any inherent defect of its own, other than lack of a proper floor and guard-rail system.

Of the six bridge failures of last year, only one

was due from impact from a derailed train, the other five being due, one to a defective angle plate, one to a collision on the bridge, one to a snow plow of too great dimensions, one to a blow from a misplaced stick of timber, and one to a bridge being still on falseworks and not ready for traffic.

Thus for two years we have not on record a single instance of failure of an iron bridge due to defects of design, and but one to any defect of material—a most gratifying evidence of progress.

Of the wooden bridges (known to be such) 13 failures are reported, with four others of unreported material which we may pretty safely classify as wood, making 17 in all. Of these, four failed from fire, which may be regarded as an inevitable disease, and a disease which is certainly kept down by care to very moderate dimensions. The total of such fires reported since 1878 is only 31. Of the bridges destroyed by fire last year, one at least (No. 8) failed only from too zealous efforts to extinguish the fire, a locomotive having been run out on it while burning in order to use the tank water for extinguishing the flames. It might have fallen any way, of course, or more careful effort might have put out the fire without its falling.

No less than six bridges were knocked down, one (No. 7) by the very curious accident of a dump car happening to drop its load on the bridge, and *no less than five others* (Nos. 5, 17, 19, 21, 22) by derailed cars, which might presumably have been rerailed or kept from striking the trusses by adequate guard-rails and rerailing devices. Thus in all, out of this limited list of 22 bridge failures of all classes, there were five iron and five wooden bridges, or 10 in all, which failed from this one cause, "knocked down by derailed cars," a fact which we hope will be duly pondered on by all responsible for the safety of trains on bridges. In this connection we cannot but refer again to the incident on the Fitchburg Railroad, mentioned in the last Massachusetts report, where a car derailed by a broken brake beam was put back on the rails by a Latimer safety guard, passed the bridge in safety, jumped the rails again after leaving it, ran three-quarters of a mile or so derailed, struck another Latimer guard at another bridge, was again put back on the rails, again passed the bridge in safety, and finally dropped the broken brake-beam beyond the second bridge, and thereafter continued on the rails. The probabilities seem to us very strong that at least half of those 10 destroyed spans would have been saved by similar protection.

It is also worthy of special note that 2 out of the 22 broken spans were "jack-knife" draws, a wretched sort of structure which can hardly constitute one per cent. of the total spans in the country, yet which furnished 9 per cent. of the total failures last year. Being entirely floorless, it is particularly dangerous in case of derailment. There are a number of these jack-knives in prominent positions around Boston, and although trains usually pass over them slowly, and they have been used safely many years, we shall be surprised if they do not yet cause trouble.

But one wooden bridge failed while under repairs, No. 18, and this from rails having been removed, so that it was, in fact, a derailment case. Four square falls are reported (Nos. 1, 15, 16, 20) on the Illinois Central's Iowa line, Green Bay, Winona & St. Paul, Evansville & Terre Haute (a combination bridge), and Prescott & Arizona Central, all being on minor lines. This is four too many; but, after all, it is a very small percentage.

As a whole, the record is very encouraging. Two or three years ago a number of serious bridge disasters happened which not unreasonably excited a feeling approaching consternation, since it was known perfectly well that there were not a few bridges in various parts of the country which had been designed for much lighter loads than are now prevalent, and, moreover, had in many cases been much less skillfully designed than they would have been a decade later.

This alarm, however, bore fruit in a very general overhauling of bridges of all classes, and that this was pretty thoroughly and effectively done is almost proven by last year's record. Starting from the beginning of these records which Mr. STOWELL has compiled, and remembering that the record for the earlier years is confessedly imperfect, we have the following gratifying record of progress:

	1879.	1880.	1881.	1882.	1883.	1884.
Bridge failures, iron	3	1	4	6	2	..
Total	16	16	38	34	27	33
Miles of track, Jan. 1, each year, 1 = 1,000	81.8	86.6	98.3	103.1	114.7	121.5
Miles per br'ge failure.	5,110	8,660	2,450	3,030	4,250	3,675
	1885.	1886.	1887.	1888.	1889.	
Bridge failures, iron	1	8	7	6	5	
Totals	25	20	30	31	22	
Miles of track, Jan. 1, each year, 1 = 1,000	125.4	128.3	136.4	149.3	156.1	
Miles per bridge failure.	5,016	6,415	4,547	4,800	7,090	

It is all but certain from this record that there never has been a year before with so few bridge failures in proportion to track mileage as last year. Considering the steady increase in speed and weight of trains in recent years, this is very satisfactory. It is greatly to be regretted that it should be left to a private individual to collect such statistics as this. They should be collected by some national authority, as we have had occasion to urge recently (March 15) in respect to all railway accidents. While fully sympathizing with the view that any avoidable extension of federal functions is unwise and dangerous, the effective collection of records like this, relating to the safe conduct of "commerce between the States," has become, by the course of events, a practical impossibility unless done by national authority. We fully believe that a mere compulsory report of all accidents, and of their nature and causes, even without the occasional investigations by a few trained experts which should naturally be one element of such a system, would have a most favorable effect. Certainly there should be some official record of such serious casualties as the failure of bridges.

CORRESPONDENCE.

Proposed Highway Bridge Legislation.

KANSAS CITY, MO., April 12, 1890.

TO THE EDITOR OF ENGINEERING NEWS,

SIR: In view of the desirability of ventilating the subject of bridge legislation, now receiving attention in your columns, it has been suggested to me to send you for publication a copy of a proposed State law brought out by a local engineers' club in co-operation with the Engineers' Club of St. Louis, before the legislature of Missouri at its last session, as was at the time noted in ENGINEERING NEWS. Enclosed I send you a copy of the bill, as remodelled from the original draft to meet various objections that had been made against the latter. After being reported by committee it was not further acted on. We expect to have it brought forward again at next session.

W. H. BREITHAUPT.

[In view of the great importance of this question and the difficulty of framing a law which shall be just right, we subjoin the bill in full (some legal verbiage excepted), and briefly comment on it editorially.]

PROPOSED MISSOURI HIGHWAY BRIDGE LAW.

Be it enacted by the General Assembly of the State of Missouri, as follows:

SECTION 1. It shall not hereafter be lawful for any municipal, public or private corporation, or for any person or persons, building or rebuilding the superstructure of a highway bridge of 20 ft. or more clear span, to open such bridge for highway traffic, or to permit it to be used, until such owner shall have filed, in the office of the county court, sufficient plans, strain sheets and statements of dimensions of the same, to exhibit the strength thereof, together with a statement under oath from one of the "bridge experts" hereinafter provided for, upon a form to be approved by the governor, showing that the said bridge superstructure has been proportioned to carry safely the maximum loads which can come upon it in its daily intended use; that it has been designed in accordance with the specifications which are generally recognized as standard among bridge engineers; that it has been built in strict accordance with said plans and strain sheets, and that tablets or signs have been attached at each end, showing for what maximum loading it is abundantly safe.

SEC. 2. The governor shall, from, time to time, appoint, upon satisfactory evidence from other skilled engineers, showing that the applicant, whether a resident of this or other State, possesses all the necessary knowledge, skill, qualifications and high professional character to perform properly his intended functions a sufficient number of civil engineers, who shall be known as "bridge experts," and who shall exercise the exclusive right of certifying to the plans, strain sheets and statements of strength of the bridge superstructures, as required in section one. Said "bridge experts" shall be entitled to receive a fee for giving such certificates, not to exceed 2 per cent. of the cost of said superstructure. They shall file with the Secretary of State a bond in the sum of $5,000, with at least two sufficient sureties, to be approved by the governor, which bond shall be renewed from time to time as required by the governor, binding them properly to exercise their functions; and they shall take an oath faithfully, impartially and carefully to perform their duties as such bridge experts. They shall pay to the State Treasurer an initial fee of $100 each, and a further annual fee of $25 each, which fees shall go into a special fund as hereinafter provided; and they shall receive from the governor a commission and license, authorizing them to act as bridge experts for bridges in this State until they resign, cease to pay their annual fees or are removed for cause.

SEC. 3. All initial and annual fees paid by the said bridge experts shall go into a special fund, to be known as the "bridge fund," out of which the necessary expenses of making certain investigations as hereinafter provided shall be paid upon the warrant of the governor.

SEC. 4. Whenever a county highway bridge of 20 ft. or more clear span is to be built or rebuilt in this State, the county court may engage one of the legally authorized bridge experts to prepare the preliminary plans and estimates of cost of the same, together with complete specifications to govern the bidders thereon. The work shall then be duly advertised, stating conditions and time of letting, in at least one county and one State newspaper, and sealed bids only shall be received. The bids shall be opened in public, the bridge expert acting as adviser to the county court, if required, and the work shall be let to the lowest responsible bidder who shall have fully complied with the specifications and terms of letting. Provided, however, that the court may, at its discretion, reject any or all bids if in its judgment these are objectionable or excessively high; in which case the work shall be readvertised, and duly let as hereinbefore provided.

SEC. 5. After a contract for a county bridge is let, the bridge expert engaged shall verify the strain sheets, approve or make the detailed plans, and make such inspection of the materials and shop work as may be necessary. When the bridge is completed and erected, and the bridge expert has been so advised by the county court, he shall visit the structure, and examine and report upon the same to the county court, and file the certificate required under section one: Provided, however, that no changes shall be made in the approved plans and specifications, without the written consent of said bridge expert; and if the said plans and specifications have not been complied with in all material respects, the contractor shall make the defects good at his own expense, and at least 20 per cent. of the sum agreed to be paid for the superstructure shall be withheld until the bridge expert has certified that the contract has been in all respects complied with.

SEC. 6. The county court shall safely keep on file all the plans and specifications of the bridge superstructure hereafter built, and these shall at all reasonable times be accessible to the public.

SEC. 7. Whenever a highway bridge of 20 ft. or more clear span in this State shall fail under a load, it shall be the duty of the county court to inform the Governor of the fact. The Governor shall thereupon appoint one of the legally authorized bridge experts of the State to investigate the causes of the failure, and to report in writing, both to the county court and to the Governor, and these reports shall be filed and be accessible to the public. Should the county court fail to report a highway bridge failure to the Governor, then the sworn statement of any three citizens of the county may serve as the Governor's warrant for ordering such investigation. The bridge expert so employed by the Governor shall be paid by the treasurer, out of the special bridge fund hereinafter provided, such reasonable sum for his services as the Governor shall approve. Should the report of the bridge expert go to show that the failure occurred from a grossly defective design, or from evident and palpable weakness or decay, or from culpable negligence in the care and preservation of the structure, then the owner shall be liable for all immediate damages resulting from the failure; but nothing herein contained shall relieve the original builder of the bridge from his responsibility under the laws of this State, or at the common law.

SEC. 8. Whenever, in the opinion of the county court, a highway bridge of 20 ft. or more clear span in this State is dangerous from any cause, and liable to fall under a load, it shall be the duty of the county court to engage one of the bridge experts herein provided for to examine the same, and report, in writing, its condition to the court; or whenever a highway bridge superstructure of 20 ft. or more span is reported in writing by an informant to the county court as unsafe, it shall be the duty of such county court to engage one of the bridge experts herein provided for to examine and report, in writing, on the same: Provided, however, that the informant shall have first filed a bond with said county court, with approved sureties, to defray all expenses and all resulting damages of such investigation, in case his allegations do not prove to be well founded.

SEC. 9. When an existing highway bridge has been reported as unsafe by a bridge expert, it shall be so placarded until the defects are made good, or until it is replaced by a new one; Provided, however, that the continued use thereof may be permitted by the county court for such loads, less than those originally intended, which it may be abundantly safe to carry.

SEC. 10. The compensation of a bridge expert for preparing the preliminary plans and estimates, together with the specifications, and approving the strain sheets and detailed plans, as well as visiting and reporting upon the completed superstructure, shall not be more than five per cent. of the cost of the superstructure, and this fee shall cover the giving of the certificate required under section one. He shall, however, be allowed the additional sum of 4 cts. per mile each way, for the necessary distance traveled in visiting the completed structure. In case the bridge expert is also engaged by the county court to supervise the foundations and masonry of the superstructure of a bridge, his additional compensation therefor shall be subject to private agreement between him and the county court. The fees of a bridge expert for examining an existing highway bridge, and reporting thereon, shall not be more than $25 per day for the time actually given to the work, and in addition thereto an allowance of 4 cts. per mile for the necessary distance traveled. The fees shall be paid by the county, upon the warrant of the county court.

SEC. 11. The Governor may, at his discretion, engage the services of any one of the bridge experts herein provided for, or of some other engineer of his own choosing, as an inspecting engineer, to check over or examine the work of any one or more of the legally appointed bridge experts herein provided for, and to report in writing thereon. Such engineer shall be paid by the treasurer, out of the "bridge fund" herein provided for, such reasonable sum as the Governor shall approve.

SEC. 12. It shall be the duty of all legally appointed bridge experts to make such exhibits of their work, and to submit such of their plans and specifications to the inspecting engineer appointed by the Governor, as may be demanded; and should any bridge expert be found to be unqualified to properly perform the duties of his office, or remiss or unskillful in his work, or make official statements which prove to be untrue, his commission shall be revoked by the Governor without refunding any of the fees paid by him, and such further remedy shall be enforced under his official bond as shall be warranted by the facts of the case.

SEC. 13. A bridge expert may be regularly employed, on private terms of compensation, in any capacity, by a city or county, but he shall not be financially interested in any contract in which he is the consulting engineer or bridge expert, neither shall he be in the employ of such contractor.

Compound Locomotives.

128 BOULEVARD DE CLICHY, PARIS, March 21, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR—I took great interest in the articles on "Compound Locomotives" in the issue of March 8 of your valuable paper, but I beg leave to correct some slight misstatements in the said article.

The small compound engines for the 24 in. gauge are by no means on the Fairlie system. They have not, as stated, two boilers and two trucks; they have but one boiler and but one truck. They are made on my own design, known as the Articulated Mallet Compound Locotive.

It is, I believe, a noticeable matter that both the smallest and the biggest compound locomotives yet made belong to that design; on one side the above named, and on the other the large eight-wheel 59 tons adhesive weight locomotives and the still larger twelve-wheel 85 tons adhesive weight ones, in course of building for the Central Ry. and the Gotthard Ry. in Switzerland, by T. A. MAFFEI in Munich.

I am unable to find for what reason the new Michigan Central compound is said to have "the compounding done with two cylinders on the Worsdell-von Borries system."

The Worsdell-von Borries system consists only of a design of starting and intercepting valve. As the Michigan Central engine is not fitted with that particular design of valve, it has nothing to do with the Worsdell-von Borrries system.

Compounding with two cylinders through a receiver in the smoke box was done by myself, long before MM. WORSDELL and VON BORRIES thought of the compound locomotives. You will find annexed the *fac simile* of a plate in my paper on compound locomotives read in 1879 before the London Institute of Mechanical Engineers. Would it be said that these sketches belong to the Worsdell-von Borries system?

There is no gentleman of the name of Woolf at the Chemin de Fer du Nord or elsewhere, connected with compound locomotives. The eight-coupled compound engines of that line were christened Woolf's engines, because the high and low pressure cylinders are somewhat connected according to the system of the celebrated English mechanic, ARTHUR WOOLF. A. MALLET.

[Mr. MALLET's main point in this communication is certainly well taken. There is little justice in christening a very original type of engine, which Mr. MALLET clearly invented and brought into public notice, by the name of two subsequent designers of details only, however prominent and able these gentlemen may have been. We, in common with most of our contemporaries on both continents, have fallen into this bad habit, but we, at least, shall no longer offend in this way, except when it is necessary to distinguish the later from the earlier forms of the Mallet type of compound locomotive, which is broadly that which has two cylinders of unequal size, one high and one low pressure, and is otherwise in substance like a common locomotive.

A brief resumé of the history of the compound locomotive will show this clearly. In 1850 a two-cylinder compound locomotive was designed by a driver on the Great Eastern Ry., England, and in 1852 two of these engines were built. The cylinders were of the same stroke, but had the piston areas as 1 to 2. The high-pressure cylinder cut off at half stroke, and live steam was admitted to both cylinders in starting. The experiment was so unsuccessful and attracted so little attention that it is only of historic interest. In 1863 an eight-wheel, three-cylinder compound locomotive was designed by JULES MORANDIERE, of the Northern Railway of France, but the engine was never built. In 1876, Mr. MALLET built some two-cylinder compound locomotives for the Bayonne, Anglet & Biarritz Ry., France (ENGINEERING NEWS, June 9, 1888); engines of this type were introduced in Russia, Germany and Spain, and the system was applied to tramway locomotives. It was as unquestionably the beginning of the compound locomotive as GEO. STEPHENSON'S *Rocket* was the beginning of the ordinary type. In 1878, Mr. WEBB converted an old engine of the London & Northwestern Ry., England, into a compound of the Mallet type; the results were so satisfactory as to lead to the construction of a compound engine in 1881-82, and this engine, like the others since built by Mr. WEBB, was designed to avoid the use of coupling rods. Mr. WEBB's engines have three cylinders. In 1880 Mr. VON BORRIES built two tank engines on the Mallet compound system for the Hanover State Ry. During the last decade compound locomotives of various types, two cylinder, three cylinder and four cylinder have been designed and built for different countries, and in many cases, as usual, the engineers have introduced modifications and details to suit their own ideas. As to the French compound engines of 24 ins. gauge, our description was certainly misleading; a correct description, with illustrations, of one of these engines was given in ENGINEERING NEWS, June 1, 1889. Reference to this number will show that the engine has two rigid axles close together, carried by the main frame, and two axles on a truck frame; the high pressure cylinders are attached to the main frame, and the low pressure cylinders to the truck frame.—ED. ENG NEWS.]

Truss Bridge Failures in 1889.

We are indebted to Mr. CHAS. F. STOWELL, Bridge Engineer of the New York State Railroad Commission, for the following list of the truss bridges on the railways of the United States and Canada which have failed under passing trains during the year 1889, together with the circumstances of each case as far as can be ascertained. The collection of these facts has in many cases been difficult, while in a few instances nothing except the bare record of the accident could be obtained. It is believed that the list is in the main correct, though probably not absolutely so, and correction and criticism are invited.

1. Feb. 13, *Illinois Central R. R.* Stock train broke through bridge near Delaware, Ia., and 11 cars were wrecked. The bridge was a wooden one and reported to have been marked for renewal in the spring. Apparently a "square fall."

2. Feb. 27, *Grand Trunk Ry.* Passenger train broke through one span of bridge at St. George, Ont. The bridge consisted of 8 spans of 50 ft. each, deck, riveted, Warren truss. The trusses were spaced 10 ft. apart on centers, and ties rested directly on the upper chords, spaced 8 ins. apart in the clear. The derailed train ran on the bridge and speedily stripped the ties from a portion of it by bunching, allowing the trucks and car bodies to fall on the lateral bracing, which gave way in one span and permitted the trusses to fall. Built, 1879. Classified as "knocked down." 13 deaths and 29 injuries resulted, making it a disaster of the first rank.

3. March 10, *New York, Lake Erie & Western R. R.* Bridge over Cayuga Creek at La Salle, N. Y., gave way under a freight train, throwing 8 cars into the stream. A car was derailed on the bridge from some unexplained cause, probably a broken brake beam, and ran into one of the trusses, knocking it down. The bridge was a single track, through, iron, Pratt truss, 105 ft. long, built by the Passaic Rolling Mill, 1875.

4. April 1, *Baltimore & Ohio R. R.* Wooden bridge over Hart's Creek, 80 miles east of Wheeling, W. Va., broke under freight train. Engine and 14 cars wrecked. Bridge was on fire.

5. April 22, *Western North Carolina R. R.* Bridge over Third Creek, near Salisbury, N. C., struck by derailed freight train and knocked down; 14 cars wrecked. A portion of the track on the bridge approach had been taken up for repairs, but by a misunderstanding of signals the train was not stopped, but ran on the bridge off the rails with the result stated. The bridge was a wooden one, 50 ft. long.

6. April 27, *Southern Pacific R. R.* Bridge over White Oak Bayou, at Houston, Tex., gave way under a freight train. Engine and 32 cars wrecked. Four men seriously and one fatally injured. The bridge was an iron, deck, pin connected Pratt truss, apparently about 150 ft. long. It appears to have rested upon timber piers at the ends, the failure of which allowed the bridge to settle down, which it did, maintaining its upright position with the train upon it and without being much broken. Classified as a "square fall," though due to defects in the supports and not in the bridge proper.

7. May 2, *Cleveland, Lorrain & Wheeling R. R.* Bridge at Maynard, O., broke under a freight train. Three men injured. A correspondent states that "a Lake Shore dump emptied itself on the bridge" and that it fell in consequence thereof. Bridge was a through, combination, Pratt truss 104 ft. long. Classified as a "wooden bridge, knocked down." [This is a very exceptional cause of failure.—ED.]

8. May 18, *Nashville, Chattanooga & St. Louis Ry.* Bridge over Stone River, near Nashville, Tenn., gave way. The bridge, which was a wooden one, was discovered to be on fire, when section men ran an engine on it intending to put out the fire with water from the tender, but the bridge broke under the engine.

9. June 6. *Alabama Great Southern R. R.* Passenger train broke through a wooden bridge near Carthage, Ala., wrecking engine and three cars. Bridge was on fire.

10. July 5, *Baltimore & Ohio R. R.* Freight train broke down bridge at Mineral Siding, O., wrecking four cars. A car with a broken truck left the track three-fourths of a mile from the bridge. The forward part of the train crossed in safety, but the derailed car struck the end post and the bridge fell. Bridge was a through, iron, Pratt truss, built by the Keystone Bridge Co., in 1877.

11. Aug. 6, *Union Pacific Ry.* Bridge near Weston, Neb., broke down under freight train. Two engines and several cars wrecked. Two men were killed and three injured. Bridge supports reported to have been weakened by heavy rains. No further particulars obtainable.

12. Aug. 28, *East Tennessee, Virginia & Georgia Ry.* Derailed freight car struck the end post of an iron bridge near Newcomb, Tenn., knocking down the bridge and wrecking nine cars. Bridge was about 150 ft. long.

13. Aug. 30, *Union Pacific Ry.* Bridge over Rock Creek, Wyo., broke under freight train, wrecking engine and four cars and injuring one man. The bridge was a wooden one, and was on fire.

14. Sept. 15, *Norfolk & Western R. R.* Passenger train went through small bridge near Lynchburg, Va., the supports of which were reported to have been undermined by a flood. Two cars wrecked and about 20 persons injured. No further particulars obtainable.

15. Sept. 16, *Green Bay, Winona & St. Paul R. R.* Bridge over the Wolf River, at Shiocton, Wis., broke under freight train, killing one man and injuring several others. The bridge was a wooden "jack-knife" draw, and judging from photograph was about 60 ft. long. It was a "square fall," though the exact cause does not seem to have been determined.

16. Sept. 16, *Evansville & Terre Haute R. R.* Bridge over Patoka River near Patoka, Ind., broke under freight train. It was a combination bridge (classified as "wooden") and a "square fall."

17. Nov. 22, *Western New York & Pennsylvania R. R.* Derailed car of freight train struck and knocked down bridge at Tuscarora, N. Y.; 12 cars wrecked. Bridge was a through, Howe truss about 100 ft. long.

18. Nov. 24, *Illinois Central R. R.* Freight train went through bridge at Aplington, Ia., wrecking engine and 15 cars, killing two men and injuring 2 more. The bridge was a wooden one, about 60 ft. long, and was undergoing repairs at the time, a portion of the track having been removed.

19. Dec. 5, *Central R. R. of Georgia.* Bridge at Rocky Ford, Ga., was struck by derailed car of freight train and wrecked with 20 cars. Bridge was a wooden one about 60 ft. long.

20. Dec. 8, *Prescott & Arizona Central Ry.* Bridge over Verde River went down with passenger train in consequence of supports being undermined by freshet. Engine and one car wrecked.

21. Dec. 8, *Chicago & West Michigan Ry.* Bridge over Paw Paw River at St. Joseph, Mich., wrecked by derailed freight train. The bridge was a wooden "jack-knife" draw, 45 ft. long. The train was derailed by some obstruction on the track on the draw span. The engine and 9 cars passed over safely, but the following 6 cars went into the river, striking the pile bent supporting one end of the draw and springing it sufficiently to let the end of the draw drop.

22. Nov. 27, *Chesapeake & Ohio Ry.* West span of Guyandotte River bridge near Huntington, W. Va., struck by derailed car of freight train and knocked down. Engine and 3 cars wrecked. One man killed and 2 injured. Kind of bridge not ascertained.

On March 31, 1880, the east span of this same bridge was wrecked in the same manner.

A number of other accidents were erroneously reported as bridge accidents during the year. Thus, it was reported that on Jan. 17 a bridge broke down with a passenger train on the Northwest & Florida R. R., near Patsburg, Ala., whereas the accident referred to was caused by a slight washout in the track, and did not happen on or near any bridge. Also, it was reported that on Dec. 14, a bridge on the Chicago & Atlantic Ry., near Decatur, Ind., broke down under a freight train, wrecking 9 cars. On investigation it was found that the only basis for the report was the fact that a young man was run over and killed on a bridge at Decatur on that day.

Below is a classified list of bridge failures for eleven years up to and including 1889. The list doe

not include wooden trestles or short openings like cattle-guards which are spanned by a single stringer. The numbers reported for 1879 and 1880 are probably considerably too small.

TRUSS BRIDGE FAILURES FOR ELEVEN YEARS, 1879-1889.

Year	Cause of Accident and Kind of Bridge.																								Total.
	Fire.			Freshet.			Undergoing repairs.			Knocked down.			Square fall.			Unknown.									
	Wood.	Iron.	Unknown.	Wood.	Iron.	Unknown.	Wood.	Iron.	Unknown.	Wood.	Iron.	Unknown.	Wood.	Iron.	Unknown.	Wood.	Iron.	Unknown.	Wood.	Iron.	Unkn wn.				
1879	1	..	..	..	..	2	..	..	..	..	..	3	..	2	..	4	1	3							16
1880	2	..	..	..	..	1	..	..	..	1	..	1	..	..	..	3	1	1							10
1881	3	..	..	..	..	3	..	..	..	3	1	5	..	3	1	7	..	12							38
1882	3	..	..	..	..	3	..	..	..	2	5	2	3	1	..	8	..	7							34
1883	2	..	..	1	5	..	..	..	1	..	..	5	2	..	..	..	1	10							27
1884	..	..	..	1	2	..	..	..	..	2	..	5	4	..	..	4	..	10							28
1885	5	..	..	1	5	..	..	..	..	..	..	3	1	..	..	1	..	14							30
1886	4	..	..	..	..	1	..	..	..	1	7	..	4	1	1	..	..	1							20
1887	6	..	..	1	2	4	1	..	..	1	3	4	4	2	..	..	..	2							30
1888	1	..	..	5	..	5	1	1	1	1	4	1	5	1	..	1	..	4							31
1889	4	..	..	..	..	3	1	..	..	5	4	1	3	1	..	..	..	..							22
Total	31	..	..	6	4	32	6	1	2	16	24	30	26	11	3	28	3	65							286
Total iron bridges																									43

[N. B.—The United States railway mileage at the beginning of 1879 was only 81,717; at the beginning of 1888, 149,913, and at the end of 1889, 161,250 by our figures, a change important to remember.—ED.]

Of the bridges destroyed in 1889 the iron bridge classified as a "square fall," and one of those classified as "knocked down" failed through no fault of the bridge proper. The former (No. 6 of detailed list preceding) gave way in consequence of the failure of its supports, and the latter (No. 2 of detailed list) as the result of the destruction of the wooden floor and consequent breaking of lateral bracing by cars falling thereon. With the exception of the last mentioned all of the iron bridges destroyed in 1889 were of the pin-connected type.

Since the publication of a similar list of bridge failures for ten years up to and including 1888, which appeared in ENGINEERING NEWS of March 30, 1889, Mr. STOWELL informs us that he has learned that one accident included therein should have been omitted. This was one reported to have occurred on the Pennsylvania Railroad at Tyrone, Pa., on March 20, 1888. It seems that the report was erroneous, though diligent inquiry at the time failed to bring forth any information as to its truth or falsity. He has since learned, however, of the failure during that year of a Howe truss bridge on another road which was not included in the list. So that the total number of failures for 1888 remains the same, though the classification is slightly changed.

Mr. STOWELL is rendering a public service by keeping this record, and we trust that every one of our readers, everywhere, will co-operate with him in this effort, by promptly forwarding to him, or to, this journal, the real facts of every bridge failure which may come within their knowledge. We briefly discuss the above statement on another page.

As of special interest in this connection, we reprint from the *Transactions* of the Am. Soc. C. E. for July, 1889, the statistics given in Mr. THEODORE COOPER'S paper on "American Railroad Bridges," the most reliable statistics which as yet exist.

AMOUNT AND KIND OF BRIDGES ON THE RAILROADS OF THE UNITED STATES.

The author attempted to collate from the official reports of the State Railroad Commissioners the data from which to form an estimate of the amount and kinds of bridges on our railroads. He found that many States had no bureaus which collected this information. Also, that many reports were indefinite and evidently incorrect. In order, therefore, to obtain more definite and reliable information, and also to get data which could be considered as truly representative of all the geographical divisions of the country, he sought it directly from the principal large systems of railroads. Many of these systems promptly placed at his disposal very full and reliable information as to their bridges.

Taking from the Railroad Commissioners' reports such data as appeared correct and complete, and adding thereto this additional information, avoiding as far as possible any duplication of the same roads, data covering nearly 60,000 miles of railroad, fairly distributed over the whole of the country, were obtained.

In order to make these data as nearly comparable as possible, the length of all double-track bridges was reduced to the corresponding length in the single-track bridges. In like manner, the length of all main tracks, omitting sidings and turnouts, was put into terms of single track. Elevated railroads, which are composed mostly of bridges or trestles, have been omitted entirely. Table No. 3 gives the general data as to quantity of bridges and trestles and the average rate per mile of track. It shows that the relative amount of bridges and trestles varies in different districts from 58 ft. per mile to 231 ft. per mile. This last, however, is excessive, from including the crossing of Lake Pontchartrain, near New Orleans, on a trestle 22 miles long. Omitting this, we would get only 162 ft. per mile as the maximum. These variations are not entirely due to geographical location, as might appear at first thought. They are also affected by principles governing the original location of each road or division of a system. The alignment and grade may have been sacrificed to the avoidance of bridges or trestles, or the contrary. From the large mileage covered by our table, we can rely with considerable confidence upon our average, as shown in table No. 3, of about 100 ft. per mile.

TABLE NO. 3.

System of Railroad, or State.	Miles of Road.	Total length of Bridges and Trestles in feet.	Lineal feet of Bridges and Trestles per Mile of Road.
New York Central and West Shore	2,894	364,722	126
New York, Lake Erie & Western	1,514	95,509	63
Other Roads in New York	3,586	445,900	130
Roads in Pennsylvania	4,352	336,957	77
Roads in New England	2,199	176,700	80
Wabash System	1,636	160,025	98
Missouri Pacific System	4,707	566,953	120
Chicago, Milwaukee & St. Paul	5,727	614,736	107
St. Louis & San Francisco	1,441	130,075	90
Denver & Rio Grande	1,458	102,195	70
Union Pacific R. R.	4,754	276,032	58
Louisville & Nashville	2,495	322,679	123
Queen & Crescent System	1,139	299,222*	231*
Roads in Illinois	8,539	707,535	83
Roads in Michigan	4,151	249,545	60
Roads in Iowa	7,778	1,019,386	135
Central R. R. of Georgia	1,487	173,975	117
Totals	59,357	6,071 946	101

* Including the crossing of Lake Pontchartrain, a trestle 22 miles long.

Taking, therefore, 100 ft. per mile as our basis of estimate, we have for the 160,000 miles of railroad in the United States 16,000,000 ft. or 3,030 miles of bridges and trestles.

Table No. 4 gives the distribution of the bridges upon 25,000 miles of railroad into spans of different lengths. [We add percentages.—ED.]

Miles of railroad	Feet.	Per cent.
	26,228 miles.	
Trestles and spans under 20 ft.	2,299,758	83.8
" 20-50 ft.	85,181	3.1
" 50-100 "	94,165	3.4
" 100-150 "	149.121	5.4
" 150-200 "	80,551	2.9
" 200-300 "	29,542	1.1
" 300-400 "	5,677	0 2
" 400-500 "	1,211	0.1
" over 500 "	1,040	0.1
Total	2,746,246	100-0
Average per mile of road	104.7	

Using this as a basis of estimate, the 3,030 miles of bridges and trestles in the United States should be distributed as follows:

Trestles and spans under 20 ft.	2,424 miles	= 727,200 spans.	
Spans from 20-50 ft.	121 "	= 18,150 "	
" 50-100 "	139 "	= 9,100 "	
" 100-150 "	120 "	= 8,000 "	
" 150-200 "	109 "	= 3,300 "	
Spans over 200 ft.	56 "	= 1,150 "	
	2,030 "	= 766,900 "	

The above includes all bridges of either wood or iron.

Using the detailed information in the author's possession as to the bridges on the above 26,000 miles of railroad, which are of wood, combination and iron, we obtain the following estimate for the amount of iron bridges on our railroad system:

Iron spans under 20 ft.	17 miles	= 5,100 spans.	
Spans from 20-50 ft.	86 "	= 12,900 "	
" 50-100 "	66 "	= 4,620 "	
" 100-150 "	9½ "	= 3,900 "	
" 150-200 "	69 "	= 2,100 "	
" over 200 ft	49 "	= 950 "	
Total	380 "	= 29,550 "	

The author's own office records contain the following iron bridges over 200 ft. spans, and they are very incomplete for spans less than 300 ft.:

Spans over 500 ft.	2.5 miles.
" 400-500 "	3.9 "
" 300-400 "	5.0 "
" 200-300 "	15.0 "
Total	26.4 "

From the previous figures it would appear that there are now in existence on our railroads the following wooden and combination trestles and bridges:

Trestles and spans under 20 ft.	2,407 miles.
" 20-50 "	35 "
" 50-100 "	64 "
" 100-150 "	97 "
" 150-200 "	40 "
" over 200 "	7 "
Total	2,650 "

Of the 2,400 miles of wooden trestle, we can consider one-quarter as only temporary, to be filled in as embankment. Of the remaining 1,800 miles at least 800 miles will be maintained in wood. This leaves 1,000 miles to be replaced gradually with iron bridges and trestles of such spans as may be most suitable for each location, probably from 50 to 200 ft.

This would ultimately make 1,600 miles of bridges for the 160,000 miles of railroad now in existence, of which only 380 miles are in iron at the present time.

The substitution of iron for existing wooden bridges will, of course, be a gradual one. The amount of work involved in this, with that required in building iron bridges for new roads, additional crossings of our large rivers to connect present and future systems of railroad, and the demands for city and highway bridges, will furnish plenty of employment for our bridge building firms.

The author has no reliable basis for estimating the amount of highway bridges demanded by the present or the future. A comparison of the relative crossings of streams by railways and highways in the more developed parts of our country leads him, however, to the belief that the lineal feet of highway bridges will be four to five times that required for railroads only.

Pin-connected Spans.—With the exception of not over a few hundred spans, the longest of which are 260 feet (lattice bridges), the iron railroad bridges of the United State for spans over 100 feet, amounting to about 7,000 spans aggregating 210 miles in length, are of the pin-connected type.

A Case of Quick Confirmation.

In December last, Mr. A. F. NIMS, City Engineer of Nebraska City, Neb., sent to this journal plans and description of two new storage reservoirs, then nearly completed at Nebraska City, stating that in his opinion the work was very unsafe and asking confirmation or contradiction of his views that he might feel more sure what attitude to take in the matter. Reply was at once made that he was entirely right in considering the work a piece of dangerous construction.

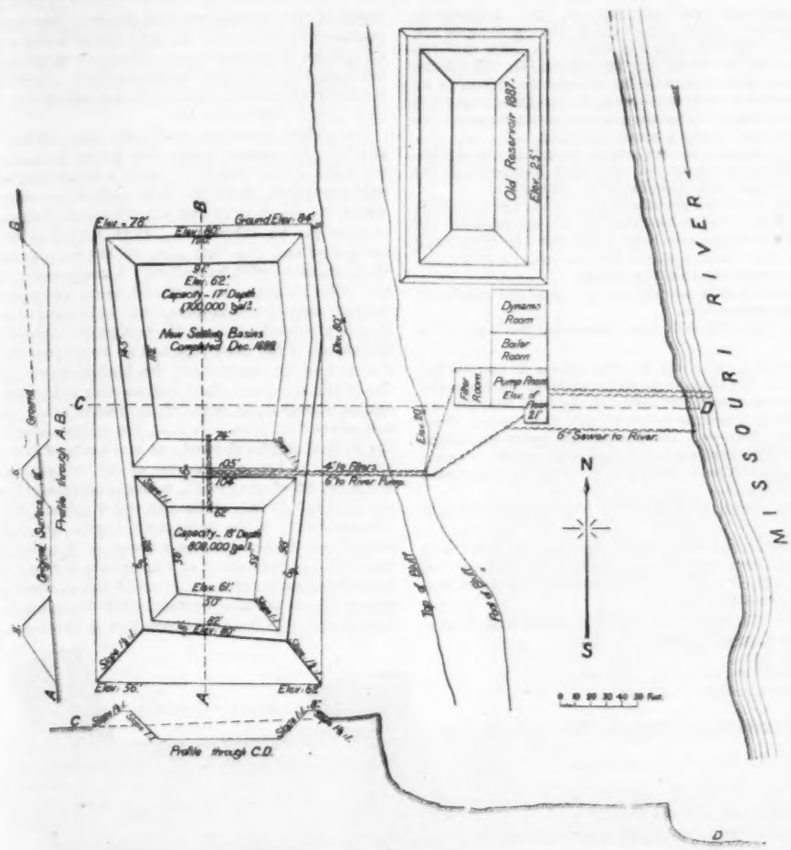
It should be said that before communicating with this journal Mr. NIMS consulted with the city attorney, and by his advice wrote to the General Manager of the Water-Works Co., informing him of the unsafe nature of the works as carried out. Instead, however, of taking this warning in the spirit in which it was sent, the company were highly indignant at the criticism of Mr. NIMS, and, as we are informed, sent word to him that when they wanted his advice they would ask for it.

That our readers may judge for themselves the quality of engineering which Mr. NIMS by virtue of his office as city engineer felt bound to condemn, we give herewith a plan of the reservoirs with enough profiles to make the character of the work clear.

As will be seen, the reservoirs are on the side of a bluff which overlooks a small portion of Nebraska City. In leveling off the site one side was excavated to make a fill on the other side. At the southwest corner the fill was 24 ft. The reservoir walls are all of earth dumped on the ground by wheel scrapers. The soil is very porous, about like that all along the Missouri river. These walls or banks have an inside slope of 1 to 1 and an outside slope of 1½ to 1, and are 8 ft. wide on top. The partition between the two reservoirs has slopes of 1 to 1 on each side and is 6 ft. wide on top.

To prevent the water from percolating through this porous soil, the reservoir walls and bottom were lined with 2-in. plank, nailed to 2 x 6-in. scantlings on the sides and laid without nailing on 4 x 4-in. scantlings over the bottom, and covered with about a foot of earth.

As the prospect seemed to be that the reservoirs would never hold enough water before failure to do any serious damage, save to the water company's own property, Mr. NIMS decided not to interfere



Plan of Water-Works Reservoirs at Nebraska City, Neb., Failed April 10, 1890.

further in the matter unless necessity should require.

The company began pumping into these reservoirs about Feb. 1, and on March 20 Mr. NIMS wrote us again regarding the condition of the works. At that time part of the inside slopes of the basins had slid down and shoved up the wooden sheathing on the inside so that some of it stood nearly vertical. The wall separating the two basins was badly washed, and in places about one-third gone. Yet nothing seems to have been done to remedy this state of affairs, and more or less water was pumped into the basins, though it seems to have leaked out about as fast as it was pumped.

The leakage into this porous soil could not, of course, keep on without some change in the condition of affairs, and on April 10 the change came. The bluff at the south end of the north basin, slid down against the filter house, crushing that structure and opening a big gap in the side of the basin. The following account of the disaster we condense from the Nebraska City *Press*:

At about 12 o'clock the south end of the east side of the upper basin, on the hill above the pumping station gave way; the hill itself, in fact, for that part of the basin is an excavation; several hundred tons of earth crumbling and breaking down. It was the work almost of a moment, and the crash, as the mass struck the filtering room of the works, was terrific. It crushed this like an egg-shell and was only stopped from taking an inside wall in its rush by the great iron filters that withstood its force. The basin was empty or the rush of water would have at east flooded the entire works if it had not done greater damage.

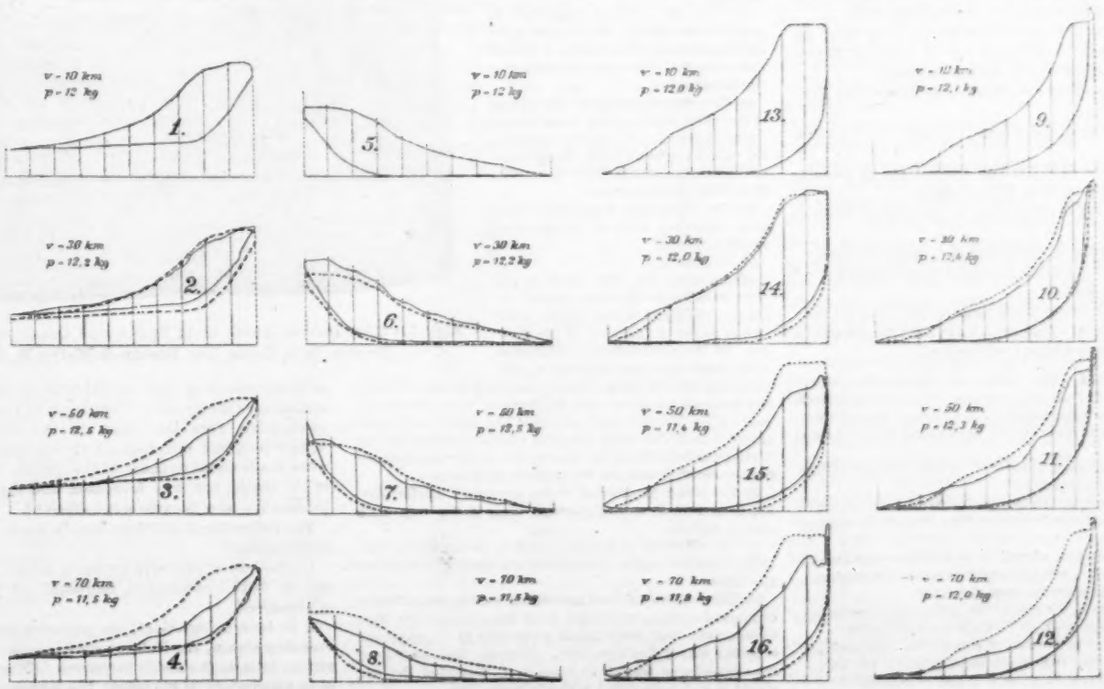
The dynamo room, furnace room and engine room are uninjured, and, except that the filters are temporarily out of service, no inconvenience will result to the public. The supply will now come from the settling basin just north of the works and on the same level; the probabilities are, however, that there will be another slide very soon that will fill this basin, the remainder of the earth wall of the basin on the hill being badly cracked and ready to give way. When this happens the water will be pumped directly from the river into the mains.

As long as the Water Works Co. and its engineers are the chief sufferers by this disaster, which appears to be the natural result of their own ignorance or recklessness, or both combined, it may seem that the matter is one in which the public or the engineering profession have no concern.

In a more proper view of the case, however, any failure of an engineering work tends to cast discredit on the profession of engineering. It is quite within the proper province of an engineering journal to expose reckless and incompetent work. At the same time it is our desire to be perfectly fair to all parties, and if the engineers in charge of the work above described see fit to defend it or take exceptions to any of the facts and figures above stated over their own signatures we shall give space to their communications.

Compound Locomotives in Germary.

Herr STAMBKE, a well-known German engineer, recently addressed the German Union of Mechanical Engineers on the subject of compound locomotives. We abstract from *Glaser's Annalen* the following notes of his lecture, which are worth careful consid-



Indicator Diagrams from Compound Locomotives, German Railways.

Why is it that the compound locomotive with the common valve gear furnishes more foot-pounds of energy from 1 lb. of steam at 150 to 180 lbs. pressure than the common type? Let us look more closely at eration, as they come from one of the most conservative railway engineers in Europe.

the work the steam does. When we have 10 to 12 atmospheres in the boiler, and 1 atmosphere at the highest is sufficient to produce the proper draught, the engine works at its maximum efficiency at the earliest point of cut-off.

Is this possible in simple engines with one cylinder and one valve? I do not believe it to be so. In the usual type of locomotive, the port is opened only 0.07 to 0.12 ins. at one-tenth cut-off and with ordinary valves. With the Allen valve, the opening is 0.24 ins. See Figs. 1 to 4. The expansion continues through half the stroke; then the exhaust commences, compression beginning on the other side of the piston head at about the same time. At one-tenth cut-off, the diagrams are as unfavorable as possible. At a speed of 10 kilos. (6.21 miles), when the steam has time to enter, the cards are tolerable, but with double that velocity evidences of throttling appear. At a speed of 70 kilos. (43.5 miles), the usual express rate, the area of the card is only half that at 10 kilos., in spite of the steam channels in the Allen valve. The compression is greater at the last of the stroke than the boiler pressure, and the expansive force so stored is lost with the opening of the valve, since the steam escapes into the valve chest. These are very poor diagrams; those at two-tenths cut-off are slightly better.

How does it stand with the compound locomotive? At two-tenths cut off the steam consumption is the same as at one-tenth cut-off before; at four-tenths cut off the same as at two-tenths before, and so on. The diagrams are now much better, both on account of the greater opening of the ports and the better motion, as regards duration of stroke over individual parts of the travel of the valve. The engine is worked more by expansion and less by throttling than before. This is one point in which the compound locomotive has the advantage.

Another point is in the smaller difference in temperature between the walls of the cylinder and the steam, diminishing cylinder condensation.

These considerations led me to make some investigations on the performance of these locomotives on the Prussian State Ry.

On Dec. 1, 1889, there were 118 engines of this class in service and 87 building. These locomotives were built in the years 1880–90. In 1880 two were finished; in 1881, two; in 1882, two; in 1883, 10; in 1884, five; in 1885, 11; in 1886, 11; in 1887, 14; in 1888, 12; in 1889, 49, and 87 will be completed during this year.

According to the service for which they were designed, they may be divided into 16 express, 35 passenger, 139 freight and 15 switch engines.

These locomotives are distributed among the divisions as follows:

The Bromberg division has 71 freight and 3 switch engines.

The Hanover division has 16 express, 22 passenger, 59 freight and 12 switch engines.

The Frankfürt division has 10 passenger locomotives.

The Magdeburg division has 29 freight engines.

The Cologne (Left Rhine) division will soon have 3 passenger engines.

The other divisions have none of this type as yet.

The directors of these lines have sent me accounts of these engines, which I will repeat.

Bromberg. — (*a*) The compound locomotive starts lightly and surely from any position. The jerking noticed during the first revolutions of the drivers passed away as the engineers become better acquainted with the locomotive.

(*b*) Steam is always generated in sufficient quantities even on the heaviest grades.

(*c*) The efficiency of the locomotive (the tractive force × the velocity) is not much greater than that of the normal type.

(*d*) The consumption of coal is 10 to 15 per cent., on an average 12 per cent., less than with the common engine.

(*e*) No sparks ever escape from the stack.

(*f*) The increase in the cost of the compound locomotive over the usual type is about 1,000 marks (about $250).

(*g*) No difference in the cost of repairs has been noticed.

(*h*) The locomotive runs much more quietly. The valve gear, however, seems to move with less evenness.

(*i*) The Directors consider the construction of compound freight engines advisable

Hanover. (Reports from three sections and two workshops.)

(*a*) No more trouble is experienced in starting a compound than an ordinary locomotive. Slight jerks are felt at starting, but they are of no consequence. Locomotives with Lindner's starting gear have less tractive power at the beginning of the motion than those with other appliances. (Lindner's starting gear is an apparatus for increasing the efficiency of the low-pressure cylinder at starting. Fresh steam is admitted to the low-pressure cylinder from the boiler. In order that this steam may not cause any back pressure in the smaller cylinder, Herr LINDNER has devised an apparatus for opening small holes in the steam valve of that cylinder at the proper time, so that the pressure on both sides of the high-pressure piston is nearly equalized.

(*b*) The steam is always supplied in sufficient quantities.

(*c*) The efficiency of the compound locomotive is not noticeably greater than that of the normal type.

(*d*) In spite of a deduction of 5 per cent., the premiums for economy given to the runners of the compound engines are always larger than those paid the other engineers. The economy varies with the nature of the sections, ranging from 5 to 15.8 per cent.

(*e*) Fewer sparks are thrown out from the compound than the normal type.

(*f*) No figures are at hand respecting the cost of the engines.

(*g*) At first, there were several defects in the starting apparatus, but these were soon removed. In one set of engines, the valve-chest covers of the high pressure cylinder cracked and the valves ate into their seats. These accidents, however, are not due to faults in design, but are to be ascribed to bad metal and casting. Valves of an alloy of 82 parts copper, 14 tin, 2 zinc and 2 antimony have worn well.

Similar occurrences have not been noticed in freight engines.

(*h*) The compound freight locomotives run more smoothly than the normal type for the same service, while the passenger compounds show little difference over normal passenger engines.

(*i*) The Hanover-Cassel Directors recommend the construction of more engines of the compound system.

Frankfort on Main.—(*a*) The compound engines start as well as the others.

(*b*) The production of steam is also as good.

(*c*) The efficiency of the compound is greater.

(*d*) In the Nordhausen section, 17 per cent. of coal; in the Frankfurt section, 18 per cent. was saved by the use of compound engines.

(*e*) When the engine is hard worked, the sparks thrown out are fewer from the compound than the simple type, and at average speed, with average loads, no sparks whatever are emitted.

(*f*) The cost of the compound is greater than that of the simple locomotive, although the figures of former years are of little value in estimating the increase

(*g*) The report speaks of the action of the valve faces, as we have stated under Hanover. At present, cylindrical valves are being tried. Repairs are not usually greater or more expensive than with simple engines.

(*h*) The compound locomotive runs more smoothly even at the greatest possible speeds.

(*i*) No report.

Magdeburg.—(*a*) The start is not quite so quick as with the normal engines. The jerky motion ceases after two or three revolutions of the drivers. Of the six freightlocomotives on hand, three are provided with a common cock for admitting steam to the low-pressure cylinder, and three are furnished with Borries' gear for the same purpose. (The Borries' gear prevents the steam in the low-pressure cylinder from creating a back pressure in the high-pressure cylinder by closing the steam way connecting the receiver and the low-pressure cylinder.)

(*b*) The steam production of the compound engine during long runs is more favorable than is the case with simple engines.

(*c*) The efficiency of the compound is greater than that of the ordinary engine; the maximum tractive force about the same.

(*d*) The amount of coal and water used is less with the compound engine, but varies with the nature of the line. Compounds that have much switching to do show an economy of only 3 to 6 per cent. Engines that have long runs economize from 15 to 20 per cent. provided the engineer is well acquainted with his locomotive.

(*e*) No report.

(*f*) No report.

(*g*) The cost of repairs of the compound as compared with the simple engine cannot yet be definitely settled.

The Erfurt division possesses no compound engines, but has conducted a number of experiments on a compound express locomotive. These investigations were made in February and March, 1889; in May of the same year, similar investigations were made with a normal express engine. The experiments were made with an open throttle and a cut-off of from 10 to 68 per cent. The train speed varied between 6.2138 and 55.924 miles an hour. The simple locomotive had Allen valves; the compound only one, that on the larger cylinder.

The Erfurt directors could give no information that can be classed under the heads *a*, *b*, etc., as was done above, but they have a large number of indicator cards, about 500 from each cylinder, from which the steam used and the efficiency of the locomotives can be calculated. Both cylinders of the compound and the left one of the simple engine were provided with indicators. A manometer gave the boiler pressure, an Ehrhardt speed indicator the velocity and a vacuum-meter the diminution of pressure in the smoke box. In the compound locomotive, the mouth of the blast-pipe had an area equal to 10.7 per cent. of the surface of the high-pressure cylinder, while the same pipes had an area in the simple engine of only 9 per cent. of the piston area. A result of the variation was that the vacuum-meter of the normal engine showed, at a velocity of 31 miles an hour, a boiler pressure of 10 atmospheres, and a cut-off of one-fourth, a water column of 7 to 8 cm. (2.75 to 3.15 in.), while the water column of the vacuum-meter of the compound engine, at a boiler pressure of 12 atmospheres, a speed of 31 miles and one-fourth cut-off, stood at 2.5 c m only (0.98 in.) The normal engine generated 8.19 to 9.01 lbs. of steam per square foot of heating surface, while the compound engine gave 6.14 lbs. per square foot at the highest.

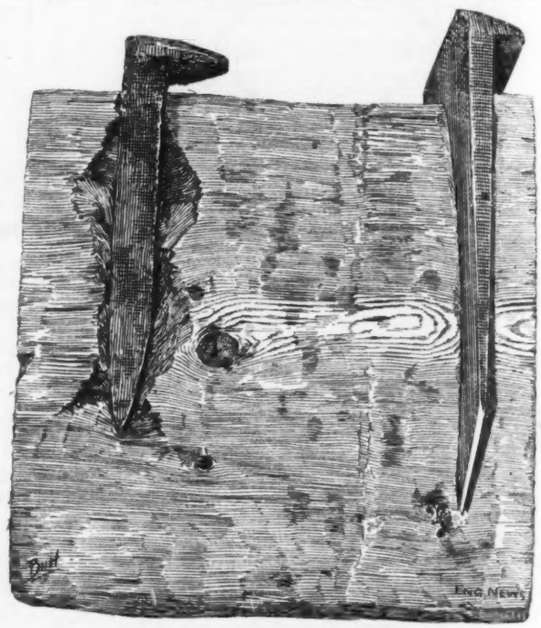


Fig. 1.—The Davies Steel Lock Spike and Common Spike as Driven in a Cedar Tie, Boston & Maine R. R.

In consequence of this variation in the vacuum, the steaming capacity and the efficiency of the compound locomotive were less than in the normal type. When the blast openings of the compound engine were made equal to those of the simple, the vacuum in the smoke box was increased and the compound locomotive now became more efficient.

The following deductions may be made from these experiments:

1. The loss of pressure between boiler and cylinder, in both locomotives, increased as the square of the speed.

2. In both locomotives, the pressure curve of the entering steam, the link remaining in the same position, falls as the speed increases. Even at a speed of 40 kilometers (24.855 miles), the influence of expansion is shown during the time the steam is entering. See Figs. 1–16.

3. The expansion line in the high-pressure cylinder frequently rises above the theoretical hyperbola; this being due to an evaporation of the cylinder water.

4. The pressure line in the larger cylinder of the compound locomotive is a descending one, but does not show the influence of the speed to so great an

extent. This is due to the larger steam ports and ways and the Allen valve.

5. The back pressure on the piston of the large cylinder of the compound engine bore the same relation to cut-off and speed that it did in the normal type.

6. The pressure in the receiver is independent of the speed but varies with the cut-off between 30 and 45 per cent. of the boiler pressure.

7. The loads being equal, the steam consumption of the compound and normal engines is about equal at low speeds; as the speed increases, the steam consumption of the compound at early cut-off is greater, at later cut-off less than is the case with the simple locomotive.

8. In these experiments there was no marked economy gained by compounding. The valves of the compound engine were not of the best, however, and the cylinders were not properly covered.

9. The efficiency of the two locomotives was about the same. A number of experiments showed that the ratio in favor of the compound type was 212:201.

10. The size of the blast pipe nozzle is of great importance.

11. The best ratio of diameters of the two cylinders of a compound engine varies with the expansion and speed.

From these experiments, conducted with proper care by officers of the Prussian railway system, and from the immense hold the compound engine has taken, in spite of a few faults not yet removed, it seems that it surpasses the simple engine in the following respects:

(*a*) In the efficiency.
(*b*) In the coal burnt.
(*c*) In the lack of sparks from the stack.

These advantages are partly counterbalanced by the following:

(*a*) The greater cost of the compound locomotive.
(*b*) The increased number of parts.
(*c*) The slight (very small) increase in cost of maintenance.

The investigations are instructive in other respects, moreover. It is fairly certain that the motion of the compound locomotive is steadier during the run than that of the simple engine; hence no great anxiety about a slight difference in the efficiency of the high and low pressure cylinders need be felt.

From the Erfurt indicator experiments, the following conclusions are of special interest:

The poor vacuum in the compound locomotive, and consequently the bad steam generation, points out the importance of carefully designing the blast-pipes. A bad design in respect to these parts, can more than counterbalance the advantages of compounding. In compound locomotives, these pipes and nozzles should have the same (or even a less) diameter as in the simple type, in order that the smaller number of impulses of the steam may produce a proper draught. In this connection, the communication on the subject that appeared in the number of the *Revue Generale des Chemins de fer* for November, 1889, giving the results of experiments on the Eastern Railway of France, are interesting. It was found that a continual partial vacuum did not exist in the smoke-box, but that the steam impulses producing the vacuum were clearly marked even at the greatest speed. In the curves there given, formed by plotting the vacuum readings as ordinates, the steam impulses were marked by apices, of angles of very small amount. At slow speeds especially at starting, the ordinates became zero after each impulse. In all cases, the curves were full of angles.

The Erfurt experiments also show that the cards from the high-pressure cylinder, the cut-off remaining the same, are much worse at great speeds; it is plain that the Allen valve should be used on both cylinders.

The Davies Steel Lock Spike.

In ENGINEERING NEWS, June 1, 1889, we described the Davies lock spike, which had been in service on different roads and was then being introduced as an improvement on the ordinary track spike. The many defects of the latter, and the numerous accidents that may be traced to it, are well known to railway men, but while various attempts have been made to obtain a spike which would give a better old in the tie, very few of these attempts have resulted in any practical success. The Davies spike, however, after extensive trial on different roads, appears to be showing a marked superiority over the ordinary spike, according to all we can learn; and while it has not been in use to a sufficient extent, or for a sufficient time to be unreservedly endorsed, it certainly commends itself as a decided mechanical improvement, to this extent at least, that railway officials are fully justified in giving it a thorough trial. On curves, this spike, by reason of its width, acts as an efficient rail brace and prevents spreading of the rails. This spike has two special features which increase its efficiency over the ordinary spike. In the first place, its taper form and sharp edges and point (sharpened on an emery wheel) cause it to enter the wood with a sharp, clean cut, severing the fibres instead of tearing and crushing them, as an ordinary blunt rough spike does. This taper form and the tight grip of the fibres makes the improved spike much superior to the ordinary form in holding power. In the second place, the spike, being driven diagonally into the tie (parallel with the rail), the pulling strain of the rail, exerted under the effects of the traffic, is not axial to the spike, but is at an angle of nearly 45 degrees to the spike. With an ordinary spike the resistance to pulling is almost entirely that which is due to the friction of the fibres, and as these fibres have in general been badly injured by the driving of the spike, this friction is not sufficient to prevent the gradual loosening of the spike. A walk along a railway track will clearly prove to those who may be unfamiliar with the subject that the ordinary spike is by no means a secure fastening for rails. A considerable item in track expenses is that of redriving spikes and putting in new spikes; this item will be reduced by the use of the lock spike, as it does not get loose and therefore does not require redriving.

We present this week two cuts made from drawings from the actual ties and spikes. Fig. 1 shows a Davies and an ordinary spike driven into a cedar tie of the Boston & Maine R. R. The object was to show the comparative effects upon the fibres of the wood, and the Davies spike was, therefore, driven vertically, to enable the tie to be split through both spike holes. The clean, sharp cut of this spike and the close way in which the fibres hug it are clearly shown. The crushing and tearing of the fibres by the ordinary spike are effects similar to what occurs in every-day practice. The difference in holding power of these spikes is very apparent. Fig. 2 shows a Southern pine tie of the Long Island R. R., split open after nearly two years' service in the track in a yard. The Davies spike is shown to have a good hold, while the fibres at the hole of the ordinary spike are very badly damaged. These ties were sent to us by the Dunham Manufacturing Co., of Boston, which manufactures these spikes, as showing the merits of their spike, and we feel confident that the results shown are to be relied upon as correct.

Fig. 2. The Davies Steel Lock Spike, as driven in a sample tie of the Long Island Railroad. [Southern pine, in track about two years.]

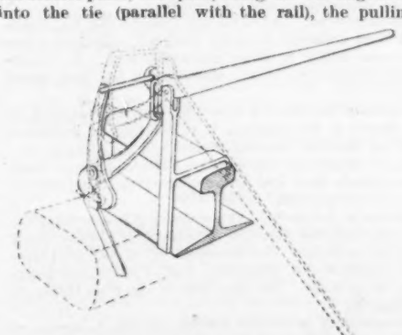


Fig. 3. Claw-bar for Drawing the Davies Spike.

The diagonal direction of the spike makes it difficult to draw when new rails are to be laid, or other track work done which requires the removal of the spikes. To meet this objection, the manufacturers designed the claw-bar shown in Fig. 3, by which the downward pull on the lever gives a pull in a direct line with the spike. By the aid of this device spikes which are perfectly tight in service may be readily drawn when necessary. The spike may also be removed by placing the wedge-shaped end of a hammer against the inclined head of the spike and then striking heavy blows on the other end of the hammer head.

The Davies spike is frequently used in connection with the Servis tie-plate, which was described in ENGINEERING NEWS, March 16, 1889. This plate is of channel section, with a middle rib if for use under heavy traffic, and the spikes are driven through slots in it. The plate distributes the pressure on the rail over a larger area of the tie than that covered by the rail flange, thus reducing the cutting of the tie by the rail flange, and enabling the spikes to be kept tight. This combination of lock-spike and tie-plate would appear to be a decided improvement in railway track. The plate is made by the manufacturers of the Davies spike, and we have received a photograph of a cedar tie sent to them by Mr. P. S. ARCHIBALD, Chief Engineer of the Intercolonial Railway of Canada. After the tie had been considerably worn and cut by both rails, one end was adzed down and a Servis tie-plate put under the rail; the other end was left in its original condition. When the tie was removed it had been in the track five years, and the tie-plate had been on it for 18 months. In the photograph the protected end shows a smooth, even face,

while the other end is deeply cut and damaged by the rail flange in the manner so familiar to persons accustomed to track work. We sent the photograph to Mr. ARCHIBALD, and he kindly sent us in January last the following letter to him from Mr. WM. RAINNIE, Trackmaster, to whom he had forwarded the photograph:

Yours of the 22d inst. received. Also a photograph of the tie I shipped you on the 20th of June last. With reference to why the tie should wear so much more rapidly the last 18 months, my opinion is that when the tie-plate was put on, the two ends of the tie were in equally good condition, but when the tie-plate was fitted on a portion of the wood on each side of the rail would have to be leveled off with the adze to make a level bed for the tie-plate; and on the other end there is no doubt that the deeper the groove got the more it would be liable to hold the wet, and cut away the faster. The tie being on a curve may also have had something to do with the cutting down of the tie. At all events, the tie is just as it was taken out of the track, and the statement made by me (that the tie had been 5 years in the track, and that the tie-plate had been applied for 1½ years) is correct.

RAILWAYS.

EAST OF CHICAGO—Existing Roads.

Ohio Valley.—This company is about to build a line from Bellaire, O., along the west bank of the Ohio River to Marietta, O. Bids have been asked for constructing a portion of the line, and work, it is stated, will begin at once. The road will follow the route of the old Marietta & Cincinnati R. R., which was surveyed and partly completed nearly 40 years ago.

Brigantine Beach.—This road has been completed from Pomona Station, N. J., to Brigantine Beach, 13 miles Ten miles from Pomona to Grassy Bay, were completed in 1889.

Concord & Montreal.—The contract for the grading and masonry on the Franklin & Tilton R. R. has been let to Moulton, O'Mahoney & Trumbell, of Lawrence, Mass. The contracts for the approaches to the Merrimac River bridge, the masonry work and superstructure of the School St. and Prospect St. bridges were awarded to J. W. Buswell, of Salisbury, Mass. The contract for the superstructure of the Merrimac River bridge has not yet been let. The roadbed is to be completed ready for the laying of the rails by Aug. 1.

Columbus, Shawnee & Hocking.—This company has completed arrangements for the construction of a 4¼-mile connecting link with the Cleveland & Canton R. R.

Cincinnati, Wabash & Michigan.—At the annual meeting of this company recently held the following directors were elected: D. J. Mackey, William Heilman, Evansville; M. E. Ingalls, Cincinnati; John Newell, Cleveland; Cornelius Vanderbilt, George Bliss, C. M. Depew, C. C. Baldwin, James Stillman, James T. Woodward, Joel F. Freeman, New York. D. J. Mackey was elected President, W. J. Lewis, Secretary and Treasurer, and Norman Beckley, General Manager. The extension from Anderson to Rushville was decided upon, work to begin May 1.

New York, Lake Erie & Western.—General Manager Bradbury of this road is quoted as saying that the company would take possession of the Fort Wayne, Cincinnati & Louisville R. R. at once, and that the matter of the extension to Cincinnati would be decided upon soon.

Hocking & Western.—A small force of men is stated to be at work grading this road near Floodwood, O. The road is projected to run from London to Athens, O., 90 miles.

Central R. R. of New Jersey.—It is stated that this company is considering an extension from Newark to Fanwood, N. J., a distance of 30 miles.

Projects and Surveys.

Delaware, Susquehanna & Schuylkill.—Incorporated in Pennsylvania to build a railway from Drifton to Eckley, Pa., a distance of about 30 miles. Eckley B. Coxe is President.

Toledo Western.—This company has been incorporated in Ohio to build a railway from Toledo, O., to Chicago, Ill. This project is an old one, a company having been incorporated and surveys made for the line some 10 years ago. The incorporators of the present company are: G. G. Hadley, J. E. Martin, Elmer White, Geo. H. Kitcham and others.

Worthington Valley.—A project is on foot to build a railway through the Worthington Valley, Maryland, to a connection with the Northern Central R. R., at Centerville, Pa. J. J. Caldwell, of Glyndon, Md., is interested.

Toronto, Hamilton & Buffalo.—Work on construction will soon begin at Hamilton, Ont., it is stated.

Lockport & Northern.—At a meeting of the directors recently held, the following officers were elected: President, Wm. Saulding; Vice-President, Willard T. Ransom; Treasurer, John Hodge, and Secretary, Chas. A. Hoag. The road is projected to run from Lockport to New Fane station, on the Rome, Watertown & Ogdensburg R. R., a distance of 10 miles. It is intended to construct the road this season.

Cannelltown & Georgetown.—Efforts are being made by the citizens along the route to secure the construction of a railway from Cannelton, Ind., along the north bank of the Ohio River to Leavenworth, Ind., on the Louisville Evansville & St. Louis R. R. The length of the line will be about 80 miles and it will traverse a fine agricultural and timber region.

Tiffin & Fremont.—This company will receive bids for the construction of its line from Marblehead to Upper Sandusky, O., a distance of 75 miles. J. A. Sloan, of Lake side, O., is President, and J. I. Kaney is Chief Engineer

New York, Schenectady & Ogdensburg.—A press dispatch from Kingston, N. Y., says:

A meeting in the interest of the proposed New York, Schenectady & Ogdensburg R. R. was held here this afternoon. President C. J. Crouse, Secretary W. S. Vanderbilt, Charles R. Knowles, Vice-President W. A. Wasson, Treasurer P. H. Flagler and nearly all the directors of the company were present. Mr. Knowles pictured the advantages of the new road. Notwithstanding the transportation routes through the Hudson and Mohawk valleys, he said, there was an interior section which was partly cut off from proper facilities. The Canadian Pacific Ry. was seeking a more direct outlet to the seaboard. It wanted terminal facilities in New York. Already it had a charter to bridge the St. Lawrence, and is about to build. The road now proposed is from Schenectady to the Poughkeepsie Bridge, at Highland, 78 miles. Then there are 11 miles to be built to complete a connection with the New York & Northern, which, it was said, that company had agreed to build. This would secure a New York terminus, and the Canadian Pacific would thus be able to avoid its present roundabout outlet at Portland and Boston. The cost of roadway, exclusive of right of way, is estimated at $11,700 per mile. As now surveyed it crosses the Albany & Susquehanna about one mile east of Guilden, and thence through New Salem and Clarksville, through the town of Coeymans to Greenville, crossing the Sawkill Creek near Woodstock, after running east of the Catskills, then coming near Lake Mohonk and thus to the Poughkeepsie Bridge.

New Jersey Belt Line.—This is the name of the proposed railway now being surveyed from Crawford to Avondale, N. J., 18 miles, passing through Irvington, East Orange, Bloomfield, and Belleville. It is stated that the line is being built in the interest of the Central R. R. of New Jersey and the New York, Lake Erie & Western R. R., whose lines it will connect.

SOUTHERN.—Existing Roads.

Richmond, Fredericksburg & Potomac.—This company will commence work at once double tracking its line from Richmond to Quantic, Va. The company has recently secured a mortgage loan of $2,000,000 for the purpose.

Richmond & Danville.—Tracklaying on the Western North Carolina R. R. has reached a point six miles from Murphy, and rapid progress is being made on the work.

Atlantic Coast Line.—The grading on the Scotland Neck extension of this road has been completed between Greenville & Kinston, N. C.

Kinneconnick.—Work is now in progress on this road, which is to run from a point on the Ohio & Big Sandy R. R. near Kinneconnick Bridge into the timber lands and quarries, a distance of about 8 miles. The Chesapeake & Ohio R. R. will furnish the rails and equipment, and the rest of the line will be built by the people owning the timber lands and quarries. The road is to be completed by Sept. 1.

South Atlantic & Ohio.—The grading has been completed to Big Stone Gap, and it is expected that the track laying will be completed by April 20.

South Bound.—The Savannah Construction Co., which has been organized to build this road, as noticed in our last issue, will, it is stated, commence soon. An installment of 20 per cent. of the capital stock has been called for.

Georgia, Southern & Florida.—The force at work on the Macon & Birmingham R. R. will soon be increased, and the division between Macon and La Grange, Ga., will be completed this season. Thirteen miles of track have already been laid and construction trains are running on that portion.

Millen & Southern.—At a meeting of the stockholders recently held, the following officers were elected: President, L. R. Millen; Vice-President, W. B. Stillwell; General Manager and Treasurer, J. W. Preston, and Secretary, W. F. Baker. The road will be run from Millen to Stering, Ga.

Ivorydale & Millereek Valley.—Harry A. Brown, of Cincinnati, O., General Manager, sends us the following concerning this enterprise:

The tracks owned by this company were laid by Proctor & Gamble in connection with their manufacturing plant at Ivorydale, O. As the location was advantageous and one of the tracks had connection with the Cincinnati, Hamilton & Dayton and the Cleveland, Cincinnati, Chicago & St. Louis railways, they were frequently called upon to do switching for other manufacturing firms; it was, therefore, decided to incorporate the company as a common carrier. The total length of the line is 2 miles. The road does only a freight switching business.

Michigan Central.—A correspondent writes us as follows concerning the extension of the Michigan Midland branch of this road, as noted in our last issue:

The proposed line is an extension of the Michigan Midland R. R. northwest, via Romeo, Lakeville, Oxford and Flushing to Chesaning, Mich., a distance of 85 miles. There will be no large bridges or tunnels and the work will be generally easy. The route is through a good agricultural country and opens up a number of thriving manufacturing towns to Detroit and the East. A preliminary survey of the line has been made, and it is expected that the estimates will be completed in a few days. A considerable amount of the right of way has been secured, and other local aid can be obtained.

Charleston, Sumter & Northern.—A. A. Howlett, General Manager, is reported as saying that this company has decided upon the construction of the extension from Sumter to Bennettsville, S. C. The engineers will take the field at once, and the construction of the road will be pushed to a completion by Jan. 1, 1891. There will be a large bridge over the Pee Dee River.

Atlantic & Danville.—The city of Bristol, Tenn., has voted $110,000 in aid of the Danville & East Tennessee R. R.

Abbeville & Way Cross.—About five miles of this line have been graded ready for the ties. Contracts have been let for a large quantity of steel rails, and tracklaying will begin soon.

Projects and Surveys.

Gulf & Chicago.—The contract for constructing this road has been awarded to a Chicago construction company. The portion included in the contract extends from Mobile to the Tennessee River, a distance of 365 miles. The president of the company is C. C. Merrick, of Chicago, Ill.

Monticello & Tampa.—This company has been organized in Florida to build a railway from Monticello to Tampa, Fla. J. H. Perkins, E. B. Bailey, J. S. Denham, T. B. Simpkins and others are among the incorporators.

Savannah & Oconee.—Chartered in Georgia to build a line of railway from the Savannah River, in Chatham County, to the Oconee River, in Laurens County, a distance of 114 miles. Among the incorporators are: DeWitt C. Bacon and Horace Smart, of Chatham County, and Martin F. Amorous, of Fulton County.

Carolina Southern.—Surveys are now in progress on this road, which is projected to run from Sumter to Chc raw, S. C. Wm. Moncure, of Durham, N. C., is Chief Engineer.

Sheffield & Seaboard.—Chartered in Mississippi to build a railway from Aberdeen, Miss., to Sheffield, Ala., a distance of 100 miles.

Burksville & Northeastern.—It is proposed to commence surveys at once for this Kentucky line. The road is projected to run from Burksville to Glasgow, Ky., 50 miles. W. F. Alexander, of Burksville, Ky., is President.

Macon & Atlantic.—A company is reported to have been organized at Macon, Ga., to construct a line of railway from Macon to Savannah, Ga. Among those interested are W. B. Sparks, J. Lane, and G. W. Austin, of Macon.

Mt. Pleasant, Santee & Little River.—Chief Engineer, John Runk, has just completed the preliminary examination of the route of this proposed road. The road is projected to run from Charleston, S. C., to Wilmington, N. C. John C. McNaughton, of 228 Dock St., Philadelphia, Pa., is President.

Abbeville & Tifton.—This company is seeking a charter empowering it to construct a railway from Abbeville to Tifton, Ga. The route is through a fine agricultural and timber region.

Salem & Roanoke Dummy.—Surveys are in progress for a dummy railway to run from Salem to Roanoke, Va. J. H. Wingate, of Roanoke, is the engineer in charge.

NORTHWEST—Existing Roads.

Chicago & Northwestern.—Surveys are in progress for a line from a point in Rice Township, Jo Daviess Co. Ill., to Galena, Ill.

Winona & Southwestern.—In accordance with the plan under date of July 15, 1889, Messrs. Joseph Walker & Sons, as fiscal agents of the Winona & Southwestern Improvement Co., have issued a second call for 40 per cent. of the total subscription on the income bonds and stock of the Green Bay, Winona & St. Paul R. R. Co.; 30 per cent. of the total subscription has already been paid. The subscription under the second call is payable April 21. Active construction on the road will begin at once.

Projects and Surveys.

Kearney, Hutchinson & Gulf.—W. H. Elliott, of Kearney, Neb., Chief Engineer, sends us the following information:

The road is to be run through Red Cloud, Bladen, Minden and Kearney, a distance of 65 miles. The route of the line is very favorable; maximum grade 1 per cent. and maximum curve 3°. Surveys are now in progress and work has commenced securing the right of way. The principal business of the road will be the local freight and passenger traffic. Geo. Whiteaker is President.

Milwaukee Belt & Terminal.—About $1,500,000 has been subscribed in aid of this road. Thos. A. King, of New York City, is Chief Engineer.

Springfield & Hillsboro.—Incorporated in Illinois to build a railroad from Springfield through Sangamon, Christian, and Montgomery counties to a point on the Toledo, St. Louis & Kansas City R. R. near Hillsboro. The principal offices of the company will be at Springfield.

Red Lake & Western Railway & Navigation Co.—Incorporated in Minnesota to build a railway from some point on Red Lake to some point on the western boundary of the State. Among the incorporators are Frank Ives and Harry E. Ives, of Crookston, Minn., and D. A. Brown, W. H. Murtfeldt, and E. O. Wires, of Boston, Mass. The principal offices will be at Crookston.

SOUTHWEST—Existing Roads.

Kansas City, Fort Scott & Memphis.—A press report states that this company has surveys in progress for an extension from Springfield, Mo., to Hot Springs, Ark.

Texas Mexican.—It is announced that this narrow gauge road running from Laredo to Corpus Christie, Tex., 160 miles, will be changed to standard gauge.

Missouri Pacific.—It is expected to have the Fort Scott & Eastern R. R., from Fort Scott, Kan., to Rich Hill, Mo., 24 miles, completed by June 1.

Atchison, Topeka & Santa Fe.—The estimated gross earnings of this company for the month of March were $2,465,522, an increase over those of the corresponding month of last year of $565,860.

San Antonio & Aransas Pass.—Surveys will soon commence for an extension from Waco to Paris, Tex.

Projects and Surveys.

St. Louis & California.—Incorporated in Arkansas to build a railway from Rogers, Ark., west to the State line. Among the incorporators are: H. L. Morrill, E. J. Smith and E. D. Kenna, of St. Louis, Mo.

Kansas City Connecting.—Chartered in Missouri to build a railway from a point on the Missouri River, opposite Quinard, Kan., via Randolph and Jackson, to Wyandotte, Kan., a distance of 25 miles. Among the incorporators are: Herman Clark, A. B. Pain and D. R. Offley, of New York City, and J. Seymour Scott, of Kansas City.

St. Louis, Cape Girardeau & Sikeston.—The locating survey for this road has been completed to Benton, Mo. The route is from a point near Cape Girardeau, Mo., to Sikeston, Mo., and ultimately to Memphis, Tenn. The division to Sikeston is to be completed this season.

Southern Arkansas.—This company has been chartered to build a line of railway from Dry Run, Dallas Co., Ark., to a point in Calhoun Co., 25 miles. Among the directors are: C. B. Field, of Chicago, Ill.; Ed. Daniel and T. T. Doyle, of Dry Run, Ark.; Geo. W. Clark, of Little Rock, Ark.

ROCKY MT. AND PACIFIC.—Existing Road.

Rio Grande Southern.—Work has been commenced on this road between the junction with the Denver & Rio Grande R. R., near Dallas, Colo., and Rico, Colo. The grading is to be completed by Aug. 1, and track-laying will go on as fast as the grading is completed. It is expected to complete the grading to Rico, Colo., this season. C. W. Gibbs, of Dallas, Colo., is Chief Engineer.

Fairhaven & Southern.—E. M. Wilson, of Fairhaven, Wash., General Manager, is receiving bids for the clearing, grading and trestling of 26 miles of this road. The contract also includes the driving of 2,500 piles.

Spokane Falls & Northern.—The contracts have been let for the extension of this road to Little Dalles; the work to be completed June 15.

Northern Pacific.—According to press dispatches from Washington this company has under consideration the construction of a belt-line railway extending from Tacoma around the head of the entire southern portion of Puget Sound to some point on Hood's Canal. The road will be built in as near a direct line as possible. The line will be extended to a connection with the Puget Sound & Gray's Harbor R. R., the acquisition of which is a part of the plan. The P. S. & G. H. R. R. now runs from Kamilchie to Montesano, Wash., and the construction of a line from Kamilchie to Hood's Canal would complete the belt line. Surveyors are now in the field, and the early construction of the line is expected.

Great Northern.—The grading has been completed on the extension from Great Falls to Monarch, Mont., 43 miles, and it is expected that the tracklaying will be completed by April 26. The line will be extended from Monarch to Neihart, 11 miles.

Projects and Surveys.

The Dalles & Southern.—This company has been chartered to build a railway from The Dalles, Ore., via the Tygh and Antelope valleys, to Prinville, Ore. Among the incorporators are: D. W. French, P. T. Sharp and Chas. Hilton.

Phœnix & Chino.—A delegation is in Washington endeavoring to secure the right of way across certain public lands and the passage of an act empowering Maricopa County to vote bonds in aid of this company. The road is projected to run from Phœnix to Chino, a distance of 160 miles. Maricopa has pledged a subscription of $280,000 when the necessary power is secured.

Las Cruces & Organs.—Incorporated in New Mexico to build a line of railway from Las Cruces east to the Organ Mountains, a distance of 20 miles. Among the directors are: Wm. B. Knight, Simon B. Newcomb, Wm. E. Baker and John H. Riley. The principal offices will be at Las Cruces, N. M.

Baker City & Sumter Valley.—A project is on foot to build a railway from Baker City, Ore., to Sumter Valley, to open up the timber and mineral lands.

Montana Coal & Iron Co.—This company has been organized to develop the coal mines of the Bear Creek coal fields in Montana. The company also proposes to build a railway from Billings to Cooke City, Mont., and thence south to a connection with the Chicago & North-western R. R.

Rio Grande & Salt Lake.—It is stated that the projectors of this railway, who had a line surveyed from Durango to Algadones, Colo., about 2 years ago, are now preparing to build the line. B. L. Cook is Vice-President and V. D. Simar is Chief Engineer.

RAPID TRANSIT.

Electric Railways.—Work will be commenced shortly on the electric railway between Augusta and Gardiner, Me. The power will be furnished by the Oakland Mfg. Co., of Gardiner, Me.

On May 5 the Ensley Ry. Co., Birmingham Mineral Ry. Co., and the Birmingham & Bessemer Ry. Co., will hold meetings to formally consolidate the companies with a fourth company, called the Birmingham Electric Co. These lines aggregate 59 miles of track. If the Board of Aldermen gives permission, the company will use electricity as a motive power. It is probable that efforts will be made to bring other lines into the combination.

The Zanesville Electric St. Ry. Co., of Zanesville, O., has been incorporated, with a capital stock of $50,000.

The street railways of Lansing, Mich., are to be operated by an electric system, using overhead wires. The cars have been ordered; they will be lighted by electricity.

At Aurora, Ill., a company has been organized, backed by New York capital, to build 12 miles of electric railway. The poles are to be 135 ft. apart, with wires 21 ft. above the ground.

The West St. & North End Electric Ry. Co., of Seattle, Wash., has awarded the contract for bridge and trestle work to Jas. H. Watson, the firm of Bryant & Howard having thrown up the contract. M. O'Day has the contract for clearing, grubbing and grading at $160 per acre. The other prices are as follows: timber in place (except frame bents and sway bracing), $14.50 per 1,000 ft. B. M.; frame bents and sway bracing, $17.50; piles, 16 cts. per lin. ft., measured below cut-off; iron, 5 cts. per lb.; earthwork, 27½ cts. per cu. yd., measured in excavation. Mr. J. P Thomson is Chief Engineer. The company has also let a contract for electrical equipment and plant, including cars, engines, boilers, dynamos, wires, poles, etc., to the Thomson-Houston Electric Co., of Boston, Mass.

Elevated Railway.—The Atlantic Avenue Elevated Ry. Co., of Brooklyn, N. Y., has been incorporated with a capital stock of $50,000. President, Austin Corbin; Vice-President, J. Rogers Maxwell; Secretary, Frank McIntosh; Treasurer, Henry Graves.

Cable Railways.—The contract for the Broadway cable line, at St. Louis, Mo., has been awarded to Wright & Mysenberg, of St. Louis, who have completed the Peoples cable line. The road is to be completed by September, and the cost of reconstruction is estimated at $300,000. Sub-contracts for stone for concrete have been awarded to the Bambrick & Bates Construction Co. and Stiefel & Ruckert. The contract for cement has been let to the Gleneve Cement & Lime Co.

The Third Avenue Ry. Co., of New York has been refused by the Supreme Court a mandamus to compel the Commissioner of Public Works to issue a permit for opening the streets for constructing a cable conduit.

Street Railways.—The Hartford & Wethersfield Ry. Co., of Hartford, Conn., will extend its line at once through East Hartford.

The Sixth Ave. Ry. Co., of New York City, intends to extend its road along Lenox Ave. (which is a continuation of Sixth Ave.) from 110th St. to 145th St.

The Pleasant Valley St. Ry. Co., of Allegheny, Pa., will build this season the Crosstown line from Federal St. to the California Ave. branch.

The Chicago & Evanston Rapid Transit Co., of Chicago, Ill., has been incorporated by R. J. Randolph, T. P. Bailey and J. M. McSmith. Capital stock, $500,000.

The Duluth St. Ry. Co. has declined to accept the ordinance granted authorizing the use of electricity on certain lines. The company will improve its present track and horse car equipment.

The Multnomah St Ry. Co., of Portland, Ore., has applied for a franchise.

HIGHWAYS.

Pennsylvania.—The uneconomic aspects of bad roads at this time are forcing themselves upon the newspapers. The Pittsburg *Dispatch*, after describing the condition of a road in its bailiwick upon one end of which $6,000 were squandered in a single year, and upon which wagons sink to their axles in the mud, says: "The cost of hauling a ton of oil-well casing three miles in that road is greater than the freight from the mill to Australia, and yet the shiftless farmers have their fingers in their mouths, and their brains suggest no remedy. It isn't much wonder that farming doesn't pay in Allegheny County."

Vermont.—Mayor Crombie, of Burlington, in his recent message to the Board of Aldermen, made the following remarks on highways: "The subject of road-making is attracting much attention all over the country. False ideas of economy have always stood in the way of realizing that the best is the cheapest. It has been demonstrated by unquestionable authorities, that good roads are cheaper to build and maintain for a period of twenty years than poor ones, and roads so constructed and maintained are not only more economical for all kinds of traffic, but are cleaner, more wholesome and enjoyable. The building and maintenance of roads requires the skill of a practical road-builder, a fact often overlooked by many intelligent men who serve the community. Good roads increase the value of property to a marked extent and actually cost the community much less."

Connecticut.—At a recent meeting of the citizens of West Hartford, the question of macadamizing the principal roads of the villages was thoroughly discussed. Mr. A. C. Sternberg outlined a general plan for the proposed improvement at an estimated expense of $60,000, the money to be raised by 1 per cent. bonds payable in thirty years; also that a tax of 1½ mills be levied. Mr. W. E. Goodwin said the town had wasted thousands of dollars on the old system of road construction. The plan for macadamizing them would be the best economy. The following resolution offered by Mr. Sternberg was passed by a two-thirds vote: That a committee consisting of the selectmen and F. C. Rockwell, C. Edward Beach, D. H. Peck and Timothy Sedgwick, is appointed to consider and report to the meeting on April 28 what highways of this town, if any, ought, in their judgment, to be macadamized, graded and improved, in what manner and to what extent, and the amount of appropriation to be made therefor. The committee will give public hearings on April 14 and 26. The meeting adjourned till April 28, when the matter of bonds will be considered.

Virginia.—The new departure on the subject of roads and bridges in Alexandria Co. made by the supervisors is being vigorously seconded by the County Court. A number of rules have been issued against road officers because of failure to keep roads in good order, especially in Washington District, the section above the aqueduct and near the chain bridge. A new road is being laid out to Falls Church district in Fairfax Co.

Massachusetts.—At Chicopee, $10,500 have been appropriated for highways and bridges. At Stockbridge, $6,600 have been appropriated for highways and bridges.

Texas.—The people of Alvin are solving the public road question by purchasing a road grader and raising a subscription fund to supplement the public road fund. Several hundred dollars have been subscribed and teams will be put to work at once. It is estimated that a road can be built 30 ft. wide with crown 2¼ ft. above bottom of ditches at a cost of $25 per mile by the use of this grader.

Tennessee.—The County Court discussed the subject of buying a steam roller in January, and appointed a committee to report at the April term. The whole summer is now before us, and it is the best time to rock our pikes. Since North Knoxville has demonstrated that a roller pays by giving a good road without delay, and using less rock, we trust Knox Co. will give us decent pikes this summer by doing the same thing. The Middlebrook pike is yet to be rocked. It would pay to roll it solid before putting rock on, and then roll the rock solid. The older pikes need touching up, and everybody who saw the steam roller break up the rough portion of the old Tazewell pike, and then make it smooth and solid, would recommend that Knox Co. should do similar work on her many pikes.—*Knoxville Journal.*

WATER-WORKS.

NEW ENGLAND.

Pittsfield, Me.—The town is moving in the matter of having a system of works established. Engineers E. H. Gowing, F. S. Palmer and H. K. Jackson, representing John Post, Jr., & Co., of Boston, recently had a conference with the citizens. The result was, that if pure water can be obtained in the vicinity of the village in the necessary quantities for household, fire and other purposes of the town, a company will be formed to put in the required works. Another meeting will be held on April 26. Books will also be opened for subscription for stock.

Machias, Me.—At a recent meeting of the Machias Water Co. to take action under the charter granted by the Legislature in 1889, several new members were elected. The charter fixes the capital at $50,000. The plan, as at present proposed, is to procure a water supply for each side of the river in the village, to be taken from springs in the near vicinity. It is understood that the company intends to enter at once upon preliminary work, and if no disappointment occurs will be prepared to proceed in the work of securing sources of supply and putting water mains in place as soon as the frost leaves the ground.

Whitefield, N. H.—The town has appropriated $7,500 for constructing works for fire protection.

Portsmouth, N. H.—The town is discussing the question of buying the Aqueduct Water Co.'s works.—A later report states that the company has sold its plant to outside capitalists.

Vergennes Vt.—The question of filtering the water supply has been discussed. The matter is in charge of the Common Council. C. T. Stevens is the Mayor.

Palmer, Mass.—The citizens have voted to extend a water main to Blanchardville.

Peabody, Mass.—About 4,250 ft. of 8, 6 and 4 in. pipe will be laid this season, and about 10 new hydrants, and 10 new valves will be set. Henry Baetje is Clerk of the Water Board.

Boston, Mass.—The Water Board has decided to take Whitehall pond, in Hopkinton, as the source of an additional water supply. The pond has a capacity of 940,000,000 gallons a day. It is the property of Eben D. Jordan, and will be taken under the right of eminent domain, it having been impossible to agree upon the price.

Reading, Mass.—The town has voted to issue $50,000 of bonds to build works according to plans made by M. M. Tidd, of Boston, last year.

Methuen, Mass.—Town Clerk Joseph S. Howe has sent the following:

The town has not decided to do anything. A committee has been chosen to consider the proposition recently made by James A. O'Neil. Water would probably be pumped from Harris' pond.

Southborough, Mass.—H. A. McMaster, Town Clerk, informs us that it is not probable that works will be constructed this year. The question is simply being discussed.

Providence, R. I.—A resolution reported by the finance committee authorizing the City Treasurer to hire $25,000 for the water-works construction account, has been passed.

Westport, Conn.—William J. Finch, Town Clerk, has sent us the following:

All that has been done yet is to have a survey made.

Litchfield, Conn.—The following is a list of bids received by the Litchfield Water Co. on April 14 for furnishing a wrought-iron equalizing tank, 30 ft. in diameter by 35 ft high; thickness of plates, ¼, ⅜, 5-16 and ¼ ins.:

Bigelow & Co., New Haven, Conn., $4,300; R. F. Hawkins, Springfield, Mass., $3,500; E. Hodge & Co., Boston, Mass., $3,495; Cunningham Iron Works, Boston, Mass., $3,434. The contract was awarded to the Cunningham Iron Works. The contract for earth excavation and foundations was awarded to Samuel Cone, of Litchfield, at 30 cents and $6 per cu. yd.

T. H. McKenzie is Chief Engineer of the works.

MIDDLE.

Tonawanda, N. Y.—The United States Water-Works Co., L'td., of North Tonawanda, has filed in the office of the Secretary of State, a certificate of increase of capital stock from $500,000 to $2,000,000.

Rochester, N. Y.—The committee appointed by the City Council shortly after the passage of the order to expend $150,000 in placing 10,000 meters during the coming season, have, instead of adopting said order, passed the following resolution:

That the executive board be, and it is hereby authorized and recommended to procure and set approved water meters during the coming fiscal year, to an extent not to exceed $20,000, under the advice of the finance committee of the common council and the chief engineer of the water-works, and to pay the cost thereof from the revenue received from water rents in excess of the other regular charter charges on said fund.

H. G. Thayer and J. Miller Kelly compose this committee.

Yonkers, N. Y.—J. F. Bevin's water supply bill has passed the Assembly. [This bill probably grants authority to the town to issue $25,000 of improvement bonds, as the City Council voted favorably upon their issue in January, 1890.—ED.]

Chateaugay, N. Y.—W. C. Stevens' bill relating to the water-works has passed the Assembly. [It is probable that this bill also grants the town authority to issue bonds for improvements.—ED.]

McKeesport, Pa.—Extensions and improvements costing $8,000 will be made next month.

Beaver Falls, Pa.—The Harmony Society has sold the entire water plant, including its franchise, right of way and all appurtenances, to H. W. Hartman. The purchaser intends making many improvments in the present works, among which will be a system of filtration. A reservoir will be built near the head of Dead Man's Hollow, on the East side of the Beaver River, above the town, into which water will be pumped from a point opposite Fetterman. The Holly system will be used, which will force water up on College Hill, Mt. Washington and Patterson Heights, points heretofore unsupplied. The proposed improvements will be commenced early this summer.

Pittsburg, Pa.—The Department of Awards has awarded the contract for pipe laying to Jacob Schneller. The contract for furnishing the valves was awarded to the Ludlow Valve Mfg. Co., of Troy, N. Y.

Lancaster, Pa.—Proposals will be received until April 24 for furnishing the valves, hydrants, special castings, pipe, etc., that will be required until April 1, 1891. Edward F. Frailey is the Superintendent.

SOUTHERN.

Roanoke, Va.—A considerable amount of new pipe is being laid.

Glasgow, Va. (A new town, probably near Lynchburg, Va.)—Contracts for a large system of works are reported to have been let.

Charlestown, W. Va.—Work will be started on a new reservoir this season. Only a small amount of pipe will be laid.

Winston, N. C.—George W. Hinshaw, Superintendent and Treasurer, has sent us the following:

About 1¼ miles of 6 and 4-in. pipe will be laid this season, and 25 to 30 new hydrants, 10 to 15 new valves, and 50 to 75 new meters, will be placed.

Aiken, S. C.—Sufficient stock of the Aiken Water & Light Co. having been subscribed, a meeting was held on April 12, and the following officers were elected: S. J. Eutriker., President; Henry Hahn, Vice-President; James Powell, Treasurer; T. Gaston, Secretary; P. A. Emanuel, Attorney.

As soon as contracts are closed with the city, and residents, the company will undertake the construction of works.

Anderson, S. C.—The Smith & Vaile Co., of New York, has been awarded the contract for furnishing pumping machinery, having a daily capacity of 2,000,000 galls.

Albany, Ga.—It is reported that the Albany Improvement Co. has been organized to construct works.

Waynesboro, Ga.—The town will soon be supplied with water from Major Wilkins' artesian well.

De Land, Fla.—The City Council is negotiating with Philadelphia parties for granting a franchise for a system of works. The general terms are satisfactory, and it is probable that the details will soon be agreed upon. If the franchise is let the work is to be completed within nine months.

Jasper, Fla.—We have received the following information from A. D. Small, Town Clerk:

The town has taken no definite action in regard to building works, but it is supposed that it will do so in the near future. If works are put in, Horne & Greene, of Jasper, will be the contractors.

DeLand, Fla.—The following is taken from the Jacksonville *Times-Union:*

The City Council is negotiating with Philadelphia parties for the granting of a franchise for a system of works. The general terms are satisfactory, and it is hoped that the details will soon be agreed upon. If the franchise is let the work is to be completed within nine months.

Florence, Ala.—The work of laying the mains for the new system is being pushed rapidly. The stone water tower is being built, and the brick pumping station is nearing completion. Col. W. A. Jeter, of the Jeter & Boardman Gas & Water Association, is Superintendent of the construction.

Columbus, Miss.—Superintendent A. S. Frierson has sent us the following information:

The storage capacity of the works is to be increased, as well as the supply. Only a few new hydrants and valves will be set.

Baton Rouge, La.—Superintendent L. P. Amiss informs us that about ½ mile of 6-in. pipe will be laid this season, and that six new hydrants will be set.

Chattanooga, Tenn.—The National Water Purifying Co. has been awarded a contract for furnishing an additional filtering plant.

Nashville, Tenn.—A bill has passed a first reading in the City Council appropriating $10,000 for the purchase of additional water pipe, and referred to the Committee on Improvements and Expenditures.—The council has appropriated $45,000 for the further improvement of the city works.

Memphis, Tenn.—Superintendent W. L. Cameron has sent us the following information:

About six miles of new mains, 16 to 8-ins. in diameter, will be laid this season, and about 100 new hydrants, 50 new valves, and 50 new meters will be placed.

Ludlow, Ky.—A bill has passed the House to amend the city's charter authorizing the issue of $25,000 of bonds for providing a water supply.

Covington, Ky.—A bill has passed the House to further amend the city charter in respect to supplying water to citizens, and authorizing an issue of $120,000 of bonds.

Mt. Sterling, Ky.—A bill has been introduced into the Legislature to incorporate the Mt. Sterling Water. Works Co.

Ashland, Ky.—It is reported that a bill has passed the Legislature incorporating the Ashland Water Supply Co.

Richmond, Ky.—The Richmond Water-Works & Sewerage Co. has applied to the State Legislature for a charter.

NORTH CENTRAL.

Sidney, O.—Improvement bonds to the amount of $100,000 have been carried. Of this amount about $20,000 will be expended in improving the water-works.

Columbus, O.—The following is taken from Superintendent A. H. McAlpine's annual report:

The pipe lines petitioned for and that are necessary for domestic service, and a more efficient fire protection, amounting to about 27 miles of pipe at an estimated cost of $178,000, should be laid during the year. An appropriation ought to be made for that purpose. Fifty-two fire-hydrants have been added during the year, making a total of 760 in service.

Martin's Ferry, O.—The work of laying the additional water mains has been commenced. A large force of men will be employed, and the work will be pushed forward as vigorously as possible.

Marysville, O.—At the special election on April 8, a majority of 20 was cast in favor of establishing works. The following officials were also elected: Mayor, Marvin Hopkins; Clerk, Lewis English; Treasurer, John Wood.

Ironton, O.—About $10,000 will be expended this year in making improvements.

Greenwich, O.—John M. Marty, Manager of the Greenwich Machine Works, informs us that they are putting in a system of works. Supplies, etc., will probably soon be wanted.

Cincinnati, O.—Superintendent Thorp has made the following recommendations:

That two new water lines be laid in Court street, from Broadway to Gilbert avenue, one 6-in. for private consumers and one 20 in. for general supply. Also the abandonment of the site and work on the new pumping station on the Eden reservoir. He advises the removal to the east end of Baker Pass (east end of the front reservoir wall), because he has found that the cost of finishing the present work will be equal to or exceed the cost of the same building in the new location, including the loss by abandonment of the present location.

Petitions for laying a quantity of 8 in. pipe have also been received.

Cincinnati, O.—A communication from J. R. Maxwell to the Board of Public Improvements respecting an improvement in the water-works system has been received, and referred to the Engineer for investigation and report. Mr. Maxwell has given his opinion as an expert upon the feasibility of constructing a reserve pump about 25 ft. above the present high-water level, which could be utilized in flood time and be at all times accessible for repairs.

Birmingham, Mich.—The construction of a new system of works has been commenced. Excavations are being made for the pipe, and for the reservoir.

Detroit, Mich.—At a recent meeting of the Water Commissioners petitions for laying about 21,040 ft. of water pipe were received. Some 24-in. pipe was petitioned for. The estimated cost is $111,512. Secretary Case has announced that the request would be practically complied with, the Board having a similar scheme in mind, and being worked out, the estimated cost to be $125,000.

Mr. Nagle recommended the removal of the old reservoir. The Superintendent was requested to report the most feasible plan of doing so.

Milwaukee, Wis.—The Committee on Water-Works has recommended the laying of a considerable amount of new water mains in the 10th, 29th, and other wards.

NORTHWESTERN.

Owatonna, Minn.—Mayor E. M. Morehouse informs us that the contract for constructing the new works has been awarded to Harrison & Hawley, St. Paul, Minn., at $28,763. Walter W. Curtis, of St. Paul, is the Engineer.

Nebraska City, Neb.—A large bluff, about 60 ft. high in the rear of the Nebraska City Water Co.'s plant, upon which the reservoirs were located, has caved in, ruining the reservoirs and falling against the building, crushing in the walls. The damage will be between $5,000 and $10,000.

Grand Forks, No. Dak.—The town will soon vote on the question of issuing $12,000 for constructing works.

SOUTHWESTERN.

St. Louis, Mo.—Sealed proposals will be received at the office of the Board of Public Improvements until July 15, for furnishing all materials, constructing and erecting at the Chain of Rocks two pumping engines and appurtenances complete. A deposit of $7,550 is required. Proposals must be accompanied by the following general plans: 1. Sectional side elevation. 2. End elevation. 3. Sectional plan through pumps. 4. Sectional plan through steam cylinders. Blank forms will be furnished upon application. Specifications, with form of contract, can be obtained, and drawings showing size and location of the pump pits can be seen at the office of the Water Commissioner M. L. Holman. Henry Flad is President, and Emory S. Foster is Secretary of the Board.

Stuttgart, Ark.—We have received the following from R. M. Shreve:

Contracts for constructing works will be let in about 60 days. The plant is to be put in by the Stuttgart Improvement Co. President, F. M. Gillett; Vice-President, S. H. Leslie; Treasurer, C. K. Leslie; Secretary, E. D. Hall. No engineer has yet been appointed. Water will be pumped from driven wells to a reservoir for fire protection, and to a tank for domestic use. Estimated cost, $15,000. Population, 2,000. The works are to be completed in six months.

Dallas, Tex.—Dr. A. R. Smith, of Colorado City, has been awarded the contract to drill the artesian well.

Houston, Tex.—Water has been struck in the new 8-in. well at a depth of 510 ft.

Boulder, Col.—The town will issue $60,000 of bonds for the purpose of putting in a water-works system. The council has advertised for bids for 1,000 tons of iron pipe, and work upon the system will be pushed as rapidly as possible.

Reno Park, Col.—(A suburb of Denver, Colo.).—Mr. Argersinger, the owner of the park, 38 Opera House Block, is now making contracts for a complete system of water works, which, when in, will furnish the owners with an abundance of pure artesian water for lawn and domestic use, at one-half city rates.

New Castle, Col.—Work on the new works has been started, and the company building the plant has given bonds to have the plant completed within 90 days. The water will be taken from a mountain spring.

Palmer Lake, Col.—The Divide Development Co. was organized on April 5 at Monument to bore for water, etc., or whatever could be found. The capital stock is $25,000. The following directors were elected for the ensuing year: Messrs. McShane, Walker, Elliott, Swanbeck and Thompson.

Wynetka, Col. (A suburb of Denver, Col.)—It is reported that a new reservoir and water storage enterprise is to be constructed.

Barnum, Col. (A suburb of Denver.)—The Beaver Brook Water Co. has completed its works, located on the west bank of the Platte River, on the property of Jas. W. Wier. The pump house is of brick, 40 ft. square. The reservoir well is 10 ft. long, 70 ft. wide and 16 deep. The engines each have a capacity of 75 H. P.

Valverde, Col. (A suburb of Denver.)—The Town Board will probably close a contract with the Citizens' Water Co. for water for fire protection.

Fort Marcy, N. M.—Proposals for furnishing material for repairing the works at this post will be received, in duplicate, until May 8. List of material required, general instruction to bidders, and blank forms of proposals, will be furnished on application to J. W. Summerhayes, Capt. and Asst. Q. M., U. S. A., Post Q. M.

PACIFIC.

Seattle, Wash.—The contract for furnishing the valves for the new main from Lake Washington, has been awarded to the Galvin Valve & Hydrant Co., of Detroit, Mich. The contract for 45 tons of lead for the pipe line was awarded to Colt, Barton & Cowles.

Medford, Ore.—The new works will be completed about May 1. Another supply well is to be dug at once. Water is pumped to two towers.

Los Angeles, Cal.—The Board of Supervisors has granted the Newhall Land & Water Co. the right of way from Newhall to San Fernando.

Oakland, Cal.—Articles of incorporation of the Blue Lakes Water Co., have been filed. The company proposes to acquire by purchase or otherwise, own, lease, mortgage and sell within and without the State of California, water and water rights, reservoirs, canals, flumes, ditches, etc., to supply cities and towns, etc. The capital is $10,000,000, and the subscribed stock $11,000. The Directors are H. D. Bacon, Daniel E. Hays, V. D. Moody, R. M. Kirkham, F. K. Shattuck, J. W. Smith, Oakland; Thomas Bell, S. A. Marshall, San Francisco; T. G. Phelps, Belmont, and A. T. Hatch, Suisun. The company will be the successor of a company of the same name organized over 15 years ago by J. S. Emery, who built a canal, taking water from Mokelumne river and running it down along the rich mother lode in Amador County, where it is used for mining purposes. The plant and the franchise of the company are estimated to be worth $1,500,000. The water of the new company will be taken from Mokelumne River. Mr. Emery and other Directors are of the opinion that to bring down a supply sufficient for Oakland, Stockton and other cities, and to put in a distribution system in Oakland, would cost about $6,000,000. It is thought that if $500,000 cash subscriptions to the new company is obtained it can take over the property of the old comp. any, wipe out its debt and have $200,000 working capital. Bonds can then be issued, and in that way money enough obtained to make the enterprise feasible.——W. B. Farwell has submitted a proposition to furnish the City of Oakland with 6,000,000 galls. of water daily for $200,000 per annum.

Pasadena, Cal.—Pasadena capitalists have submitted a proposition providing for the saving and storing of storm water, by the erection of a dam at a suitable site across the Arroyo Seco. The reservoir, as estimated, would hold about 4,000,000,000 galls of water. The site of the proposed basin commands an elevation of 1,100 ft. It is proposed to consolidate the Pasadena Lake Vineyard Land & Water Co., the Pasadena Orange Grove Water Co., and the North Pasadena Water Co., in order to carry out this scheme.

CANADA.

Cote St. Paul, P. Q.—A deputation has been appointed to wait upon the Water Committee of the City of Montreal, P. Q., to ascertain whether the city could supply the village with water.

South London, Ont.—The London Water Commissioners have decided to allow "London South" consumers to continue the use of water until after the coming vote on the condition that they sign a special application therefor. By a previous resolution it had been decided to cut off all such services on April 15.

PROJECTS.

Tennille, Ga.——Wayne, Neb.——Pulaski, Va.; L. S. Calfuch——Merrimac, Mass.——Newton, N. J.; J. S. Kuituer, Town Clerk.

ARTESIAN WELLS.

Glenwood, Ia.—The well has reached a depth of 1,400 ft.

Abilene, Tex.—Bids for sinking a well will be received by Henry Sayles until June 2.

New Orleans, La.—The Sanitary Association proposes to sink several wells for flushing gutters and general sanitary use. E. Fenner is Presidentof the association.

IRRIGATION.

Salt Lake City, Utah.—Articles of incorporation for the Alturas Land & Irrigation Co. have been filed. The incorporators are: James B. Black, Nicholas Treweek, William Babcock, Jr., Joseph H. Young and C. T. Stevenson, all of Salt Lake City; John Condron, and E. B. Lemmon, of Hailey, Idaho. The capital stock will be $500,000, divided into 500 shares. The business of the company will be to supply water for domestic, municipal or manufacturing purposes, to cities, towns or villages, for the irrigation of land and other purposes. The offices of the company will be in Hailey, Idaho, and Salt Lake City.

Loup City, Neb.—A proposition submitted to this precinct to vote $75,000 in bonds to aid in the construction of a 13-mile water-power canal, a large storage lake, dam etc., has resulted favorably.

Ceres, Cal.—Bids were received for the construction of 11 miles of canal, the excavation amounting to 850,000 yds., by the Turlock Irrigation District, on April 15. R. M. Williams is Secretary.

Los Angeles, Cal.—The Crystal Springs Land & Water Co. will probably issue additional bonds. S. H. Mott is Secretary.

Pasco, Wash.—An Irrigation District has been formed by the freeholders of Franklin County under the new law recently passed by the Legislature. The water supply will probably be taken from the Columbia River, at the head of Priests' rapids, where there is a sufficient fall to operate four irrigation pumps, each having a capacity of 2,000,000 galls. per day. Engineer J. D. McIntyre will soon start up the Columbia to make surveys, and in a short time the actual construction outfit will be at work on the canal. The canal will be 24 ft. wide at the bottom, and 8 ft. deep, and its course will run over a section comprising 200,000 acres of the best land in Franklin County.

Fresno, Cal.—The Kings River Storage & Irrigation Co. has filed articles of incorporation with the Secretary of State. Moore & Smith are the principal stockholders. It is proposed to secure control of 500,000 miners' ins. of water, which covers all that is not now appropriated. A large dam will be built in Kings River Cañon for the storage of flood-waters, and two others will be built further up the river.

SEWERAGE AND MUNICIPAL.

Street Work.—At Coatesville, Pa., contracts have been let for macadamizing Main and Chestnut streets.

The Borough, of Reynoldton, Pa., has commenced the work of paving its streets. The street between McKees. port and Dravosburg will first be paved.

At Parkersburg, W. Va., it has been voted to issue bonds for $50,000 for street paving.

At West Superior, Wis., contracts for street paving, aggregating $15,000, have been let to Rhodes & Rogers.

At St. Louis, Mo., $100,000 have been asked by the Board of Public Improvements for street and alley improvement, and $61,600 for street reconstruction.

At Kirkwood, Mo., it has been voted to issue $10,000 in bonds for street improvements.

At Council Bluffs, Ia., the City Council has decided upon a considerable amount of grading and paving. Proposals will be opened in May.

Sewerage.—At Gloucester, Mass., bonds for $400,000 are to be issued for sewerage and sewage disposal.

A bill has passed the New York legislature providing for a system of sewerage at Elmira, N. Y.

A bill has been introduced in the Kentucky legislature providing for the construction of sewers at Newport and Dayton.

At Savannah, Ga., a considerable amount of sewer work is now in progress. It is principally 15-in. and 24-in. pipe.

At Chicago, Ill., an ordinance has been introduced for the construction of all sewers throughout the city by special assessment.

The committee on sewers at St. Paul, Minn., has recommended the construction of sewers on a number of streets.

A report on the sewerage of Duluth, Minn., has been made to the Board of Public Works by Mr. Rudolph Hering, of New York, and Mr. Andrew Rosewater, of Omaha. The separate and combined systems are recommended for different districts. Intercepting sewers will eventually be required.

At Albany, Ore., it is proposed to issue bonds for $40,000 for a system of sewers.

A vote will be taken at Seattle, Wash., on a proposition to issue $110,000 for sewers.

At Albuquerque, N. M., it has been voted to issue $50,000 in bonds for sewers.

Water Power.—The North Anson Improvement & Water Power Co., of North Anson, Me., has been organized to erect and maintain a dam across the Carrabasset River above the Somerset Ry. bridge in North Anson village, and to improve the water power. Capital, $10,000. Ben. S. Collins, President; Edwin Collins, Treasurer; Augustine Simmonds, Clerk.

ELECTRICAL.

Electric Lighting.—The Oldtown Electric Light Co., of Oldtown, Me., has a contract for 16 arc lights, at $1,000 per annum.

At Middlebury, Vt., a contract for electric lighting has been awarded to the Thomson-Houston Co. There will be 72 arc lights, at $1,300 per annum.

West Troy, N. Y., has voted to appropriate $16,250 for the purchase of an electric light plant, and $7,000 more for maintaining the electric light system.

At Whitehead, N. Y., a contract for electric lighting has been awarded to the Whitehall Silk Co., at $2,900 for 10 arc lamps of 1,200 c. p., and 72 incandescent lamps of 25 c. p.

The Elizabeth Electric Light Co. has been organized at West Elizabeth, Pa. Capital stock, $10,000.

A bill has been introduced in Congress to incorporate the Washington Electric Lighting Co., with S. M. Bryan, W. W. Rapley, J. G. Gardner and others as corporators, to erect and operate an electric light plant to furnish light and power in the District of Columbia. Capital stock, $500,000.

The Wilmington Gas & Electric Lighting Co., of Wilmington, N. C., has made a bid to furnish light at the same price as last year: $2 per 1,000 ft. for gas and $10.50 per month for electric arc lights. For an increase in the number of arc lights used last year the company proposes to reduce the price to $10 each.

At Goldsboro, N. C., the city has a contract with the electric light company for 4 additional arc lamps of 48 c. p. and 80 incandescent street lamps of 25 c. p. All lights are to be in operation by June.

The electric light companies of Cincinnati, O., are to be consolidated.

At Vincennes, Ind., an ordinance has been passed making a contract with the Vincennes Electric Light & Power Co. for 10 years. There will be 200 incandescent lights of 30 c. p. at $2.50 per month per light.

At Racine, Wis., a contract has been awarded to the Badger Electric Light Co. at $46 per light of 1,200 c. p.

The contract for an electric light plant at Litchfield, Minn., has been awarded to the Fort Wayne Electric Co.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Utica, N. Y.*—The following bids were received for the construction of a plate girder viaduct, with asphalt pavements and stone sidewalks:

Groton Bridge Co., plate girder, complete for travel	$68,160
Milliken Bros., plate girder, complete for travel	59,790
Vermont Construction Co., plate girder, complete for travel	59,467
Hilton Bridge Co., plate girder, complete for travel	57,000
Hilton Bridge Co., plate girder, complete for travel (wood floor)	41,000
Hilton Bridge Co., 240 ft. draw and cantilever, complete for travel	74,000
Massillon Bridge Co., plate girder, complete above masonry	54,500
Wrought Iron Bridge Co., plate girder, complete above masonry	53,814
James Ritchie, plate girder, no paving, no masonry	56,000
Wallis Iron Works, plate girder, no paving, no masonry	43,765
Penn Bridge Co., plate girder complete for travel	55,000
Pittsburgh Bridge Co., plate girder, complete for travel	53,400
Variety Iron Works, plate girder, complete above masonry	46,849
Dean & Westbrook, agts. Phœnixville Bridge Works, plate girder, complete for travel, except masonry in end abutments	41,316
Dean & Westbrook, agts. Phœnixville Bridge Works, plate girder, steel joist, plank floor complete	39,000

The contract was awarded to Dean & Westbrook for a plate girder viaduct 470 ft. long, 20 ft. spans, 60 ft. wide, and with a floor system of steel joists covered with plank.

Cincinnati, O.—The City Engineer has been ordered to prepare plans and specifications for the Eighth St. viaduct.

Washington, D. C.—A bill has been introduced into Congress to incorporate the Georgetown Union Bridge & Ry. Co. for the purpose of constructing an iron bridge across the Potomac River on the piers of the present Free bridge. The company is also authorized to lay railroad tracks. G. G. Boteler and J. E. Clements, of Virginia; George W. Cissell, G. J. Johnson, L. O. De Lashmutt, L. D. Wine and T. E. Roessle, of the District of Columbia; O. Horsey and D. C. Winebrenner, Baltimore, Md., and others are the incorporators.

Roanoke, Va.—The American Bridge & Iron Co. will be reorganized under the name of Walton, Wentworth & Hunter. The new company will have a capital stock of $200,000.

Bibb Co., Ga.—The County Commissioners have decided to build the Hartley bridge.

Knoxville, Tenn.—The bridge over First creek, at Broad street, will be rebuilt. The cost will be about $7,500.

Morgan Co., Ill.—Morgan Co. and Road District No. 3 have closed a contract with the Columbus Bridge Co. for an iron bridge across Indian Creek, northwest of Jacksonville, Ill., for the sum of $1,200. It is the intention of the County Commissioners to replace all the wooden bridges across the principal streams in the county with iron bridges as the old ones give away, the county paying one-half the cost and the road district the other half.

St. Paul, Minn.—The St. Paul and Minneapolis *Pioneer Press* says that at least 7 or 8 bridges will be put under construction in St. Paul during this season. The most important is the Broadway bridge which will cost according to the engineer's plans, $350,000 and work will begin immediately upon the passage of the act granting the authority. Kirkland & Starkey have the contract for the substructure at $86,594.——The contract for the substructure of the Sixth St. bridge has already been let, and operations will begin at once by the same firm who expect to undertake the one at Broadway. The structure is to cost $176,602, of which amount the sale of bonds in the sum of $55,000 have been authorized by the council. The balance will be assessed against property to be benefited. This bridge will span the Phalen Creek ravine from Brook St. to Hoffman Ave. The plans for the superstructure are now well under way, and will soon be completed.——An iron bridge is to be erected on Selby Ave., over the Milwaukee tracks, for the accommodation of the cable line extension. The superstructure will cost $69,071, and the substructure, $21,575. The railway companies leading from the city will build several bridges within the coming few months. One will be erected on Western Ave. over the Manitoba tracks, to cost $6,000, one over the Northern Pacific right of way on Como Ave., one over the Manitoba tracks on Lexington Ave., one over the St. Paul & Northern Pacific and the Manitoba tracks at Grove St. from Eighth to Seventh Sts., and two over the Manitoba tracks at some points yet to be designated.

Sioux City, Ia.—Work has been commenced on the pontoon bridge across the Missouri River at this place.

Vancouver, Wash.—Soundings are being made for the proposed bridge across the Columbia River at this place.

Canals.—*New York State.*—The bill appropriating $500,000 for the improvement of the State canals has passed the New York State Legislature.

CONTRACTING.

Street Work.—The Park Commissioners, New York City, have awarded the contract for taking up and re laying granite block pavement with concrete foundation, and resetting curb stones, in transverse road No. 3, Central Park, to George F. Doak: concrete in place, $2.97 per cu. yd.; granite block pavement relaid, 57 cts. per sq. yd.; bridge stone relaid, 7 cts. per sq. ft.; old curb adjusted and reset, 7 cts. per lin. ft.; blue stone curb, 6 ins. thick $1.20 per lin. ft.

The City Commissioner, Baltimore, Md., has received the following proposals for broken stone for macadamizing Park Heights Ave., as follows: Benjamin Kepner, per perch, $1.95; W. A. Hare, section No. 1, 71 cts., section No. 2, 77 cts.; G. W. Peddicord, section No. 1, 78 cts., section No. 2, 80 cts.; John G. Schwind, per cu. yd., $2.25; George Berry, for both sections, $1.45.

Contracts have been awarded by the Board of Public Works, Milwaukee, Wis., as follows: To T. R. Weissmann, for furnishing $1,000 worth of gravel for street repairs, at 41¾ cts. per cu. yd.; to Wm. Forrestal, for laying 6 and 16 in. water mains, at 21¼ and 49 cts. respectively; to John J. Crilley, for laying 8-in. water mains, at 27½ cts.; to Henry Vogt, for repairing the cedar block paving on 9th St., from Grand Ave. to Cedar St., at 83 cts. per sq. yd.

Slag.—At Denver, Col., the Board of Public Works has, at the recommendation of City Engineer McIntyre, awarded the contract for furnishing slag in place to cover the embankment at the outlet of the 31st St. main, to J. E. Riley & Co. at $1.25 per cu. yd.

Public Buildings.—The Board of County Commissioners, at Vancouver, Wash., will build a court house at that place, at a cost of $40,000.

A court house is to be built for Dixon Co., Neb., at a cost of $25,000.

A jail is proposed to be built at Brookings, So. Dak., but no definite action has been taken.

Pier Work.—Ross & Sanford, of Baltimore, Md., are building a large iron ore pier at the Pennsylvania Steel Works, Sparrows' Point, Md. The pier will be 700 ft. long, not including the approach, which will be 232 ft. The pier is to be 100 ft. wide with six railway tracks. Four steamships can run alongside and discharge cargo. The pier is to be built on the double-deck plan and is to be completed by June.

The following proposals for building a new pier and approach at the foot of 45th St., North River, have been received by the Board of Docks, New York City: John H. Flaherty, $43,490; R. P. Staats, $43,647; Fogg & Scribner, $44,375; Joseph Walsh, $45,000; John Gillies, $45,950; P. Sanford Ross, $46,800; W. P. Kelly, $48,883. The contract was awarded to John W. Flaherty.

Conduits.—The following proposals for a small piece of trenching and laying pipe for underground wires have been received by the Fire Department, Buffalo, N. Y., Mensch Bros., $559; Jas. Boland, $649; L. Hetterich, Jr. $818. The Department's wires in the restricted district are nearly all underground.

Shaft Lining.—The following proposals for furnishing iron lining for shaft No. 17¼, of the New Croton Aqueduct, have been received by the Aqueduct Commissioners New York City: Jonson Foundry & Machine Co., $65 per ton; Caldwell, Wilcox & Co., $75; Joseph Edwards & Co., $84; Robert Smack & Co., $110.

Stone, Sand and Cement. The following proposals have been received by Capt F. A. Mahan, U. S. Engineer Office, Buffalo, N. Y.: For 1,000 cu. yds. of rubble stone: P. G. Straub, Buffalo, $1.78 per cu. yd.; Ira Farnsworth, Buffalo, $2.50; Franklin & Olson, Buffalo, $2.25. For 1,800 cu. yds. of broken stone: P. G. Straub, $1.25; Ira Farnsworth, $2; Franklin & Olson, $2.40. For 1,000 cu. yds. sand: Fox & Holloway, 70 cts., Wm. E. Carroll, 80 cts.; P. G. Straub, 89 cts. For 1,800 cu. yds. pebble: Wm. E. Carroll, $1.40; Fox & Holloway, $1.80; P. G. Straub, $2.29. For 3,300 bbls. of Portland cement: Johnson & Wilson, New York, $2.25 per bbl. for Saylor's; James H. Ross, Buffalo, $2.45 for Burham & Co. cement, 20 cts. reduction per bbl. if admitted duty free; E. H. Crawford, Buffalo, $2.45 for Miller & Son's; Howard Fleming, New York, $2.54 for Gibbs, 19 cts. per bbl. reduction, if admitted duty free. Emile Thiele, New York, $2.48 for Hilton, $2.83 for Dyckerhoff; reduction of 18 and 23 cts. respectively, if admitted duty free.

PROPOSALS OPEN.

Brick.—About 500,000 brick for paving sidewalks. N. Smart, Chairman of Street Committee, Portland, Me., April 21.

Street Work and Sewers.—Regulating, grading and draining Van Cortlandt Park; 12, 15 and 18-in. pipe sewers, with manholes and basins; regulating, grading curbing, trap block paving, flagging, etc The Department of Public Parks, 49-51 Chambers St., New York City, April 23.

Sewers—A cut 3,026 of 12-in. pipe sewer, 762 ft. of 20 x 30 in. single course brick, 300 ft. of 18 in. brick, 50 ft. of 16 in. brick. John A. Coleman, Commissioner of Public Works, Providence, R. I. April 23.

Roads.—Building 3 roads. About 39,000 cu. yds. of earth excavation, 200 cu. yds. rock excavation, 300 cu. yds. of split stone masonry, in mortar; 541 cu. yds. of dry rubble masonry, 311 sq. yds. of culvert paving, 1,230 cu. yds. of rip-rap, 100 cu. yds. of ballast, 7,400 ft. of fencing, 20 stone bounds. Plans and specifications at the city engineer's office. The Water Board, Boston, Mass. April 23.

Sewer.—Laying 50,000 ft. of sewer pipe. A. Hinchman, Mayor, Waco, Tex. April 24.

Water-Works Supplies.—Pipe, castings, valves and stop boxes; also hauling pipe and trenching. E. F. Frailey, Superintendent of Water-Works, Lancaster, Pa. April 24.

Dredging.—Dredging about 30,000 cu. yds. of mud at E. 24th St., East River. The Board of Docks, Pier A, North River, New York City April 25.

Street Work.—Repaving & repairing streets. Louis Wagner, Director of Public Works, Philadelphia, Pa. April 28.

Street Work and Sewers.—Grading, curbing, macadamizing, Telford paving, granite block paving, etc. Plans and specifications on file. Henry Flad, President Board of Public Improvements, St. Louis, Mo. April 29.

Wharf.—At Kingston, Ont. A. Gobeil, Secretary, Department of Public Works, Ottawa, Can. April 29.

Macadamizing.—On a large number of county roads. Henry H. Pendleton, Clerk of Board of Ohio County Commissioners, Wheeling, W. Va. April 29.

Street Work and Pipe Laying.—Regulating, grading, flagging and curbing sidewalks. Resurfacing roadway with broken trap rock and trap rock screenings Laying water mains. The Commissioner of Public Works, 31 Chambers St., New York City. April 29.

Street Work.—Granite block pavement on concrete foundation. The Commissioner of Public Works, 31 Chambers St., New York City. April 30.

Sewers and Street Work.—Sewers, grading, and repaving with Medina dressed block stone. W. P. Rice, City Engineer, Cleveland, O. May 1.

Paving.—Laying 1,500 sq. yds. of granite block roadway on the main road. The County Commissioners, Charleston, S. C. May 2.

Gas Works.—L. G. Nesmith, Secretary, Agnew's Asylum Trustees, Archer Building, San Jose, Cal. May 6.

Water-Works.—Materials for repairing the works. Capt. J. W. Summerhays, U. S. A., Fort Marcy, N. M. May 8.

Artesian Well.—Sinking a well 2,500 ft. deep. Henry Sayles, Chairman of Water Committee, Abilene, Tex., June 2.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Schenectady Locomotive Works, of Schenectady, N. Y., are building consolidation freight and ten-wheel passenger engines for the East Tennessee Virginia & Georgia; among them are two compound freights, with cylinders 20 and 29x24 ins., and a compound passenger engine, cylinders 19 and 27x24 ins. Two ten-wheel engines have been delivered to the Chicago & Northwestern, and an engine to the Troy Steel & Iron Co.

The Baldwin Locomotive Works, of Philadelphia, Pa., have delivered two freight engines to the Alabama Great Southern.

The Roanoke Machine Works, of Roanoke, Va., have built a consolidation freight engine for the Norfolk & Western.

The New York Locomotive Works, of Rome, N. Y., are building 6 freight engines, weighing 47 tons each, for the Columbus, Shawnee & Hocking Valley.

The new freight engines on the New York Central were designed by Mr. William Buchanan, Superintendent of Motive Power. They have six 64-in. drivers, 19x26-in. cylinders, 58-in. boilers, and weigh 60 tons.

The Cleveland, Cincinnati, Chicago & St. Louis has contracted for 10 large passenger engines that will weigh 122,000 lbs. each without the tank. The tanks are to hold 3,700 galls. of water each. These engines are to have three pairs of driving wheels 66 ins. in diameter, cylinders 18x24 ins. and fire-boxes 106x42 ins. The engines are to be delivered during May and June. After receiving the engines now under contract, the road will have 454 first-class locomotives, about 40 per cent. of which are new. Mr Turreff, Superintendent of Motive Power is reported as saying that they still need about 50 more, as the business of the system is increasing more rapidly than the power is being increased.

The Brooks Locomotive Works, of Dunkirk, N. Y., have recently turned out the following engines: Cleveland, Cincinnati, Chicago & St. Louis, 20 ten-wheel, cylinders 19x24 ins.; 10 six-wheel switch engines, cylinders 18x24 ins. Baltimore & Ohio Southwestern, 10 ten-wheel, cylinders 19x24 ins.; 5 eight-wheel, cylinders 18x24 ins.; 2 six-wheel switch engines, cylinders 18x24 ins. Chicago, Rock Island & Pacific, 2 six-wheel switch engines, cylinders 18x24 ins. Chicago & Grand Trunk, 10 eight-wheel passenger, cylinders 18x24 ins. New York, Chicago & St. Louis, 10 moguls, cylinders 18x24 ins. Au Sable & Northwestern, 3 moguls, cylinders 15x20 ins. Vanegas, Cedral & Rio Verde (Mexico), one passenger engine. The following engines are now under construction: Cleveland, Cincinnati, Chicago & St. Louis, 10 ten-wheel, cylinders 18½x24 ins. Wisconsin Central, 10 ten-wheel, 18x24 in. cylinders. Lake Shore & Michigan Southern, 25 ten-wheel, freight. New York Central, 25 mogul, freight. Illinois Central, 15 six-wheel switch engines.

Cars.—The Decatur Car Works, of Decatur, Ala., will build 150 fruit and 100 coal cars for the Alabama Midland and 100 fruit cars for the Savannah, Americus & Montgomery road.

The Terre Haute Car Works, of Terre Haute, Ind., are building several hundred box cars for the Baltimore & Eastern line. Also 200 freight cars for the Milwaukee Lake Shore & Western.

The Roanoke Machine Works, of Roanoke, Va., have built 200 box cars for the Norfolk & Western, and are building 300 more; 100 coal hopper cars are to be built; also two refrigerator cars for the Roanoke Brewing Co.

The Denver & Rio Grande has recently let contracts for a large number of cars, aggregating nearly 3,500.

The Wagner Palace Car Co., of Buffalo, is building a number of cars for the limited trains on the Lake Shore & Michigan Southern.

A new private car is being built for General Superintendent Miller, of the Pennsylvania Southwest lines, at the Columbus shops.

Wells, French & Co. are building 500 freight cars for the Milwaukee, Lake Shore & Western.

The Atlanta Car Co., of Atlanta, Ga., is having plans prepared for its proposed works. The site has been chosen and the grading of the grounds will soon begin. Orders for the iron and wood-working machinery will be placed at once. J. C. Peck, of Atlanta, Ga., is President, and J. G. Healey is Secretary and Treasurer.

The Bloomsburg Car Co. is building 200 box cars for the Iron Car Co., of New York. These cars are to be equipped with the Westinghouse air brake and Hinson coupler. They are for use on the East Tennessee, Virginia & Georgia R. R. The company is also building a large number of contract rotary dump cars for shipment to Central America.

Vestibuled Cars.—The J. M. Clay Vestibule Car Co., of Chicago, has been incorporated, and will manufacture, buy, sell and lease vestibule and other cars. The incorporators are Frederick J. Hoyt, John M. Clay and Leslie Malone.

Car Heating.—The Botsford Car Co., of Cleveland, O., has a contract from the Cleveland, Lorain & Wheeling R. R. Co. for fitting the passenger equipment of that road with the Botsford method of heating. One train is already equipped and in service, and the work of fitting up six cars, now being built for the same road at Jeffersonville, Ind., will commence as soon as the cars are ready. The cork-lined hose used with the Botsford system is said to be a success.

Brake Car.—The Illinois Central R. R., has fitted out an instruction car which is to be sent over all the lines of the road to instruct the trainmen in the working of the Westinghouse automatic brake, preparatory to using it more extensively in freight service.

Snow Plow.—The Denver, Leadville & Gunnison R. R. has received a new Jull snow plow from the Rogers Locomotive Works, of Paterson, N. J. It was built expressly to order for service in the Alpine cut. The plow is 64 tons in weight, and built for service on narrow gauge tracks. It cost $15,000.

Track Bolts.—The Bush Interlocking Bolt Co. has received an order from the Merchants' Bridge Co., of St. Louis, Mo., for 3,000 sets of interlocking bolts, to be used on the new bridge.

Boiler Works.—A boiler manufacturing plant is to be established at Milwaukee, Wis., by the E. P. Allis Co.

Fire Boat.—A steel fire-boat, the *New Yorker*, has been built for the New York fire department by the Jonson Foundry & Machine Co., of New York. She is 125 ft. 6 ins. long, 26 ft. beam, 350 tons displacement.

Filters.—The consumption of water at Chattanooga, Tenn., has increased so much that the water comyany has ordered additional filters from the National Water Purifying Co., of New York. This is the third order, increasing the original filter plant of 3,000,000 galls. capacity. The consumption is now over 6,000,000 galls. per day, all of which passes through the filter plant.

Metal Market Prices.—***Rails.***—New York, $33.50 to $34 old rails, $23.50 to $24 for iron, $21.50 for steel. Chicago: $35 to $36; old rails, $22.25 to $22.50 for iron, $20.50 to $21 for steel. Pittsburg: $33 to $34; old rails, $23.50 to $24 for iron, $21 to $22 for steel.

Track Materials.—New York: steel angle bars, 1.75 to 1.90 cts.; spikes, 2.10 to 2.15 cts.; track bolts 2.9 to 3 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts Pittsburg: splice bars, 1.80 to 1.95 cts. for iron; spikes, 2.10 or 2.20 cts. delivered at Chicago or St. Louis; track bolts, 3 cts. with square, and 3.10 cts. with hexagon nuts. Chicago: splice bars, 2 cts. for steel and 1.80 to 1.95 cts. for iron; spikes, 2.05 to 2.10 cts.; track bolts, 2.90 cts. with square, and 3 cts. with hexagon nuts.

Pipe.—Cast iron, about $27 to $30 per ton, according to competition and amount of order. Wrought iron, discounts as follows: 49½ and 40 per cent. on black and galvanized butt-welded, 60 and 49½ on black and galvanized lap-welded. Casing, 50 per cent. discount.

Lead.—New York, 3.85 to 3.90 cts.; Chicago, 3.75 cts.; St. Louis, 3.70 cts.

Structural Material.—Chicago: iron or steel angles, 2.60 cts.; tees, 3 to 3.10 cts.; universal plates, 2.50 cts. for iron; 2.55 cts. for steel up to 16 ins. wide, 2.70 for wider steel; steel sheared plates, 2.80 cts.; beams and channels, 3.20 to 3.40 cts. Pittsburg: angles, 2.30 cts.; tees, 2.75 cts.; beams and channels, 3.10 cts.; sheared bridge plates, 2.30 cts.; universal mill plates, 2.40 cts.; refined bars, 2 cts.; steel plates, 4.25 to 4.75 cts. for firebox; 3.20 cts. for flange 3 for shell, 2.90 for tank.